Guidance and Prediction

M. B. Pande
M. A (Psy), B Sc , M Ed , Ph D.

Urban Arts, Publications Division,
A-201, Satya Apartment, Masab Tank,
Hyderabad 500028.

Guidance and Prediction

M. B. Pande
M A (Psy.) B Sc M Ed , Ph D

Urban Arts, Publications Division,
A-201, Satya Apartment, Masab Tank,
Hyderabad 500028

M.B. PANDE
M A (PSY) B Sc M Ed Ph D
Bhagirath 3 farmland, Ramadas peth NAGPUR-440010

All rights reserved including the right to reproduce this book, or any portion thereof in any form

Printed in India

by Mrs. D. P Shinde

at Gurumurthy Printing Press, Hyderabad

First Edition, 1984

Price Rs. 50/-

This book has been published with partial assistance from National Council of Educational Research and Training New Delhi

Cover Design- Vivekananda

Sales territories - India, Bangladesh, Pakistan, Srilanka.

Published by

Mrs. D.P. Shinde
Director,
Urban Arts Publications Division,
A-201, Satya Apartments, Masab Tank,
Hyderabad-500028

CONTENTS

Preface 1

Aim of Secondary Education, Individual Differences, Changed needs of Society and Individual, The problem, The Hypotheses and the field, Differential psychology, The General Scholastic Aptitude, Differential Scholastic Aptitudes, The triune character of mind, Interest - a determiner of a specific course of study, The interest inventory, Personality, The personality test.

1. Predictor Variables : 14

Differential measurement at 14+, The DSA Sub-battery of this study, Interest measures, The interest inventory, Measures of B1N and F1C traits, Teacher's estimates of personality, The procedure, The Age group, The criterion, Why humanities and Science?, Evaluation, Teachers' Estimates of achievement, Scaling of Scores

2. Parameters and Functions 28

Test reliability, Reliabilty of the Interest inventory, Standard errors of Sample statistics, SE Coefficients of correlation, SE of Differential statistics, Validity, Factorisation of variables of the battery, The four factors, Factor-variances Rotation of factors, The "Varimax" Solution (1) First rotation, (2) Second rotation, (3) Third rotation, (4) Fourth rotation, (5) Fifth rotation (6) Sixth rotation, The four rotated factors - (Varimax solution), Variances of the Rotated factors, Norms,

3. Regression and Prediction 50

Regression, Regression Coefficients, Multiple Regression Equations, The composite variances, Multiple R, Prediction, Prediction of Scholastic Achievement, The predictive battery and the two sub-criteria, Predictive Validity, The cut-off points for the normally successful students, Discriminant Function.

4. Retrospect and Prospects 76

Interpriting results, Rotated factors, A retrospect, A prospect

References 87

Appendix - A 96

Appendix - B 98

Appendix - C 100

Appendix - D 101

Appendix - E 102

कर्माणि प्रविभक्तानि स्वभावप्रभवैर्गुणैः ।

' The duties are divided according to the Primordial configurations (Prenatal qualities), born of their respective nature."

- Bhagavadgita 18/41
Lord Krishna,
2507 B. C

"Each individual must rise or sink to the level for which he is fitted by the quality of his tissues and of his soul."

Man the Unknown
Dr. Alexis Carrel,
1959 A D

INTRODUCTION

The secondary school world in India is yet to be research-conscious, hence sometimes even normal information is hard to come by. Six years of valuable guidance of Dr Varma for which I owe a deep debt of gratitude to him, is mainly responsible for the completion of the research presented here

This study was conducted on the age group of 14 + i e students of Class IX The Kothari Commission (1964-66) proposed extension of general education upto 16+ ie, upto X Class Presently diversification of secondary education is done in Class XI and students opt for any one of the three streams - Humanities or Arts, Science and Commerce Since no variable of the battery of this study is based on scholastic achievement of students, this battery of eight predictor variables - Differential Aptitudes, Intetest and personality can conveniently be used to select students for the three streams in class XI of Higher Secondary and Junior Colleges and to predict their scholastic achievement at the end of XII Class i e. in the H S S.C. examination.

The advantage of a fundamental research is that it has a longer utility than any other piece of research The N.V, IR, DR, Science Interest, Humanities Interest, B1N and F1C tests can be administered to a X Class student The regression weights would be calculated from his scores in the above tests. Further statistical calculations lead us to obtain ry values in Science and Humanities for every student of class-X The critical point of discrimination (Fisher's Discriminant Function) is already worked out in this research study for humanities and science streams After calculating critical points of discrimination, for students it can be safely decided to what stream in class XI either Humanities or Science a student should be admitted in reference to the critical point established by the researcher.

Surprisingly, the author had also suggested in 1965 vocationalisation of education after 16+ i e after X class along with academic courses - Humanities, Sciences and Commerce proposed by the Kothari Commission. It is a tragedy that we have failed to vocationalise the higher secondary education till this day There are pious hopes in the Seventh Five year plan i e. after April 1986 the Government of India would insist upon the states to vocationalise higher secondary education and would be giving sumpuluous grants to the States to do it.

Still to arrest wastage and stagnation in higher secondary education and save money and energy of men concerned, proper selection of students for Humanities, and Sciences will be imperative and useful Prediction of performances of students in the H S S C examination before their admission in Class XI will be helpful to students and parents. The predictor variables of the battery of this research study can serve the twin purposes stated above at the higher secondary or junior college stage

I am highly obliged to Dr. R. G.Bernreuter, Pennsylvania. U S A and to Dr Stephen wiseman Manchster, U K, for their permission to use the Personality Inventory and the 'Devon Interest Test respectively and to Profs J P Guilford, Paul Horst R L Thorndike and P E. vernon for the reprints of their articles and suggestions through personal communications

My thanks are due to Dr E A Pires, formerly Principal, Central Institute of Education Delhi, to Dr K. G. Rama Rao, formerly Director, Bureau of Educational and Vocational Guidance Government of India. Delhi and to Dr. P. Razdon, Principal Teachers' Training College, Hindu University, Varanasi for their advice and encouragement in the course of this study I am grateful to my colleagues in the University College of Education, Nagpur, for their counsel and to the Headmasters of the secondary schools in which my tests were administered for their generous co-operation.

Mention cannot be made individually of my teacher friends who asisted me in administering the various tests and furnished me with the estimates of 'Achievement and Personality' at the expense of their time and energy I am thankful to them all

I am indebted to the National Council of Educatinal Research and Training for giving a grant of Rs 3000/- for publishing this Ph D. research. Because of certain cifficulties the publication took a longer time than stipulated The NCERT had kindly extended the period of publication and obliged the author.

Mrs D P Shinde, Director of Urban Arts, Hyderabad has taken great pains in printing and publishing this doctoral thesis in book form, I am thankful to her. It is hoped that the book will be useful to the teachers, headmasters, principals and even parents in selecting students for the streams in class XI for guidance and predicting their achievement in XII class Undoubtedly, it can be instrumental in arresting wastage and stagnation in higher education

M. B Pande

APPROBATION

Mr Pande seems to have done a most commendable job. The thesis is well written, comprehensive in scope and represents a worthwhile contribution to existing practice and knowledge in the general area of the prediction of academic achievement.

The amount of work involved in conducting the research for this thesis was indeed rather prodigious and Mr Pande is to be congratulated on the effort and perseverance which he devoted to the project.

The work also has practical applications for student selection.

Mr Pande has done very good work and is to be congratulated on his accomplishment.

8th December 1965

George A. Ferguson
Professor and Chairman
Department of Psychology
McGill University
Montreal, Canada

PREFACE

Aim of Secondary Education :

A student comes to a Secondary School to be given the means for his all sided development and an end of striving, suited to him An inheritor of the social order, he expects an all round development of his self-a sharpening of his intellect, a widening of horizon of his knowledge, cultivation of the sense of belongingness to society through Secondary Education

As a prospective contributor to the enrichment of his social heritage, opportunities are to be provided for him here, so that he carves out a groove-a career-for himself, of his own choice to stand on his own legs after he goes out of this stage of education at 18 The responsibility of the present day secondary school in India is greater because of universal and free primary education upto 14+ and the consequent expansion of secondary education whereby many students come to secondary schools from homes where there is only slight educational environment.

Individual differences :

Moreover, adolescence is a period of great stress and strain, a period of psycho-physiological transition and transformation and therefore, the most important period of an individual's life The psychological researches on measurement of abilities, interests and personality have proved that they grow during adolescence reaching a climax in the prime', i e between 14+ to 16+. Individuals differ greatly in abilities interests and personality make-ups and the differences are especially important at such critical times as adolescence (14 +) and maturity (18 +)

The Problem of Planning an educational Programme becomes acute when opportunities are to be provided for a large number of individuals with wide differences Drawing our attention to this fact Dr Mudaliar writes, "In view of the fact that education upto the age of 14 has been made free and compulsory under the Constitution, students with a very wide variety of talents will be seeking education in future. This postulates that our secondary schools should no longer be 'single track' institutions but should offer a diversity of educational programmes calculated to meet varying aptitudes, interests and talents which come into prominence towards the end of the period of compulsory education." To fulfill this, 'enrichment' of the secondary school programme, diagnosing and fostering varied abilities, interests and personality patterns of students between 14 to 18 has become the need of the hour in our country

Changed need of society and individual :

The world has witnessed an extra - ordinary, rapid change in the last half century and more especially in the last twenty-five years The failure of educational programme to meet developmental needs of human beings in consonance with the development of society is being dramatically displayed in India. Sir Fred Clarke's words, "If we conducted our medical and engineering services and our industrial production with the same slipshod carelessness, the same disregard to precision of thought and language, the same wild and reckless play of sentimentality or class prejudice or material interest masquerading as principles, with which we carry on our public discussion about education, most patients would die, most bridges would fall down and most manufacturing concerns would go bankrupt" addressed to the English nation could be relevant for us also, in the present circumstances The industrial programme for example, has made effective use of psychological tests and has attempted successfully to measure probable proficiency in any task by presenting 'know-how' situations which reproduce on a small scale, samplings of the type of activity which success in that function demands and has thus gained through enhanced operation-efficiency of the workers Human talent is no less important to the present and future progress of society than material resources This is to be realised and attended to in our country on priority basis

The diversities of each and every student are to be diagnosed through psychological tools, and fostered, so that a student with abilities in this or that course of study learns to make the most satisfactory use of his talents in the field of his choice for the good of the society.

It enjoins upon us an added responsibility of proper selection and guidance of students for these streams Dr. Mudaliar declares "A democracy is based on faith in the dignity and worth of every single individual as a human being. The essence of a democratic society is not only the tolerating but the welcoming of differences which make for fhe enrichment of life" A nation needs not only intelligent scientists but bright politicians, humane social workers, resourceful agriculturists, skilled technicians, enterprising tradesmen, edifying artists and even good house wives

The Problem :

Selection of students for diversified courses in secondary schools according to the differences in their nature and prediction of their scholastic achievement at the time of selection or commencement of secondary education are the outstanding problems before us. If they are solved properly much of the colossal national wastage and stagnation of human potential in our education can be arrested

Presently , selectiou of students for electives is done on the basis of their marks in the annual examination only. Selection by this 'creaming-off' process by virtue of which the more intelligent students with greater 'g' ability are admitted into science course and the rest distributed amongst other courses is educationally unsound and socially suicidal

Academic prediction should be an important aim of our examining process Differential measures of a pupil's scholastic promise are our only hope With a view to enabling those whose concern is secondary education to know and measure the individual differences among students in respect of aptitudes or the innate and current potentialities which denote relative promise for their future development in a field of study, the interest or the structural dispositions which determine the direction of future scholastic performance and personality or the totality of an individual's being, this study seeks to offer necessary psychological tools. Decision about a future course of study best suited to a student, with a promise of success in it can advantageously be taken at 14 + which is the age when the range of ability becomes fairly differentiated and significantly wider.

The hypotheses and the field :

To sum up, this research study is based on the following hypotheses,

1) That together with cognitive abilities or 'Differential Scholastic Aptitudes', Interests and Personality shape scholastic achievement of students at the secondary stage.

2) That the respective cognitive abilities, interests and Personality patterns of students required for scholastic achievement in secondary education differ in kind or degree or in both.

3) That it is possible to differentiate between the candidates intending to offer courses at the secondary stage at the beginning of the courses with the help of their measures on Aptitudes Interest and Personality variables of the battery

4) That the subsequent scholastic achievement of such students at the end of the course of study can be predicted with the help of the predictive battery at the commencement of the courses of study i e at the beginning of class IX.

Twelve secondary schools with diversified courses-especially Science and Humanities - in the Vidarbha region of Maharashtra, both from urban and rural areas are chosen for administration of the various tests of the predictive battery School marks in the diversified subjects obtained by students offering the two courses of study in the annual promotion examination of class IX serves as the criterion.

Differential Psychology :

A mass of experiments of Sir Galton-the father of Differential Phychology of Cattell, Munsterberg, Gilbert, Kraepelin, Ferrari, Stern, Binet, Thorndike, Merriman, McNemar, Feigngold, Burks, Holzinger, Newman, Freeman, Jones and others has proved that the child's structural characters produce wide individual differences in both general and special abilities of individuals These differences are conspicuous by their contrast in adolescence Anne Anastasi has reported significant mean differences between sexes also, in her study of several psychological traits including both aptitude and personality characteristics of adolescents.

The General Scholastic Aptitude :

Intelligence is the power of an individual for adaptation to the environment and his capacity to reshape and remodel it for his progress It is dormant in infancy but grows and develops gradually with years as a continuation of functional development and emergence of new qualities consequent upon the various stages of development in the structure and complexity of the nervous system and biological development It attains its maximum height in adolescence *"The I Q fad", according to Stansfeld Sargent "which raged during the 1920's and saw the term applied indiscriminately, has declined To-day intelligence tests are seen in wider perspective They do one thing only, indicate mental alertness and learning ability"

Intelligence is now viewed as an ability underlying all intellectual operations and in school situation as a general scholastic ability, i e a general average of the various aptitudes for learning and profitting by it. It operates mainly from 6 + to 16 + when general education is provided to students

Differential Scholastic Aptitudes :

Intelligence tests do not measure mental patterns of a high degree of complexity because they are capable of measuring simple elementary patterns only In an adolescent mind the patterns get complicated by the development of their powers through an interplay with environment resulting into an accumulation of acquired patterns. This operation starts at 14 + In a secondary school (i.e after 14 +) we are more concerned with the differences in the degree to which a pupil possesses the various abilities—the pupil's abilities to acquire knowledge and skills demanded for a specific course of study — or with the differential scholastic abilities Differential Scholastic abilities or aptitudes represent a specialized combination of abilities constituting this or that 'talent'

Though most tests that are referred to as aptitude tests are ability measures, the term aptitude is employed when prediction of future success is the primary purpose for use of the tests Besides discovering latent learning capacities which can not be recognised by achievement tests, the aptitude tests give a measure of scholastic promise in a particular field of study, i e they give a preview of how well a student is likely to do even along lines yet untried

Summarising this, * Albert Crawford states, "Aptitude testing provides one way of guiding youth, at different stages, toward appropriate wide rivers of learning and some times even up to one or another of their main tributories". For many students this evidence of differential readiness to learn in a field of study as contrasted with other fields and profit by it, is offered at 14 +

---

* A Hundred Years of Psychology, F Flugel, 1953.

The differential Aptitude Tests battery of Bennett, Seashore and Wesman and the Yale Education Aptitude battery are used for differetial scholastic prediction While the YEA is mainly aimed for college freshmen (17 +) the DAT is effective at both 9th and 12th grades The YEA is intended to measure facility in transfer of p evious schooling in secondary schools to a series of courses at the college level Therefore, it has less prognostic value at the secondary level as compared with the College Freshmen level Both are validated against scholastic achievement Thurstone's PMA batteries are used for both college freshmen (17 +) and 8th graders (14 +) He used minimization of intercorrelations as the criterion to develop his PMA battery. When Thurstone employs the term 'validity' this refers, therefo e, to absence of correlation of the separate tests with internal criteria i. e. the several primary factors themselves Had it been Thurstone's aim to construct a scholastic aptitude battery he would have selected tests on the basis of their relative correspondence with an external criterion as school marks, grades or standardized achievement tests as is the case with the YEA and DAT batteries

D. M Verma developed a Differential Scholastic Aptitude tests battery on the lines of PMA and DAT batteries for IX graders His predictive battery of eight tests N, IR, V, DR, P, S, Fd and M is multipotential in application and measures mental abilities known to be largely unrelated functionally The tests in his battery were validated against the external criterion, i e. the school marks which was and still is the only possible criterion in India, however defective it may be The use of Dr Verma's DSA battery for scholastic prediction has been demonstrated by its application to four subjects-Language (Marathi), Geography, Science and Mathematics of Secondary Schools

The triune character of mind :

Though differential aptitude tests are reasonably adequate for scholastic prediction, very recent researches have shown that certain traits of personality and charater play an important role in shaping scholastic success Eysenck holds that the tests of personality and interest when combined with knowledge of a candidate's intellectual ability make prediction considerably more accurate These tests are regarded as complementing the purely intellectual type of test-the aptitude or ability test

---

* Fo ecasting College Achievement, Crawford, Burnham, 1946.

Education aims at the all round development of an individual. Any educational programme should, therefore, be directed to train the whole mind * "Human behaviour flows from three main sources - knowledge, emotion and desire", observed Plato, "knowledge has its seat in the head, it is the eye of desire and can become the pilot of the soul Emotion has its seat in the heart, in the flow and force of the blood, it is the organic resonance of experience and desire Desire has its seat in the loins, it is bursting reservoir of energy" Dr Radhakrishnan, the former President of India, in his University Education Commission Report states that, "Cognition, Feeling and Will, though logically distinguishable, are not really seperable in the concret life of mind These three sides which answer to the familiar distinction of Jnana, Bhakti and Karma-express themselves through theoretical contemplation aesthetic enjoyment and practical activity These are found in different proportions in different individuals" Insisting on the use of interest inventories and personality tests together with aptitude or ability tests Vernon writes, "The fundamental fact is that abilities together with interests and personality traits tend more often than not to together" In his factorial study of the multiphasic Strong, Kuder and Bell inventories W M C Cottle has reported seven factors in the four instruments used, two of the factors being common to the two personality inventories and has proved that personality and interest inventories are complementary and not duplicatory Hull in his classic studies tried to exprese the relationship between achievement, ability and interest He suggested that ability and interest combine multiplicatively to produce achievement rather than additively Expressing this relationship symbolically he proposed the following equation

Achievement = K (Ability X Interest)
where K is a constant

Interest - a determiner of a specific course of study :

While scholastic aptitude indicates innate and current potentialities of a student - the 'Power' that governs, interest gives direction to this power and determines a specific field of study for its fuller utilization. Burt has admitted that interest together with abilities and temperamental dualities shape individual differences in scholastic achievement Establishing a close relationship between aptitude and interest, Super defines aptitude as a measure of the probable rate of learning which results in interest and satisfaction Strong holds interest as an activity and an indicator of satisfaction. In the opinion of McDougall of the Hormic School, interest is a conative tendency determined by our instincts and sentiments Kuder calls interest a 'way of feeling,' 'a frame of mind'. Explaining the comprehensive character of interest Jersild states "Interests are more than a cluster of favoured activities. They represent, in the aggregate, modes of life in which the human being's emotional well being and his social relations are deeply involved " It is generally accepted that an interest-experience consists of cognitive, conative and affective elements

---

* Man's Emerging Mind, N. J Borrill, 1957.

Eventhough interests are influenced by environment and experience, they are fairly stable. The following correlations were found by Strong between two sets of interest scores for students of 11+, 14+ and 17+ age groups when retesting was done at varying intervals :

TABLE 1 1

STABILITY OF CURRICULAR INTERESTS

Interval	11+	14+	17+
1 year	.62	69	.80
2 years	51	57	..
3 years	31	.	68
4 years	31	.	.
6 years	.	.52	.
9 years	.	.	.56

Suggesting that the curricular interests can be recognised Strong s results have shown a fair degree of stabilty of interests of secondary school entrants (14+). Super agrees with Strong that students vary considerably in their interests and are qualified by virtue of these to succeed in different courses of study. Anastasi (1961) has reported that perhaps academic criteria against which most multiple aptitude batteries have so far been validated, are not clearly differentiable on the basis of aptitudes. She concludes that differences in performance in specific courses depend primarily on interests, motivation and emotional factors For the last sixty years psychologists have been interested in the measurement of interests. But the research and the results not been directly utilised for scholastic prediction on a large scale.

The Interest Inventory :

It is only during the last three decades that researches such as those of Peel and Lambert (1951), Wiseman and Fitzpatrick (1954), Lovell and white (1958) have shown a trend towards global investigations concerning the relationships of interests of students with scholastic achievement The Peel and Lambert interest test which is an information test uses a single score -

$$\left\{ \frac{P-A}{P+A} \times 100 \right\}$$ which asseses a 'bias of interest'

This interest score is a difference-score and shows the bias in favour of practical interests over academic interests of 11+ students The Devon interests Test which was first constructed by Fitzpatrick (1951) yielded a single score of practical interest as above and is more successful than the Peel and Lambert test because it proved to be the second best predictor in his whole battery. In a further research of this test in 1954 Fitzpatrick proved it to be more discriminating when interest items contained 'a distractor' an item not belonging to that category of interest It yielded two separate scores - an A-score (Academic interest score) and a P-score (Practical interest score) Items were grouped in boxes of six items each-two practical, two academic, one social and a strong distractor This test was applied in 13 + selection in Devon county in modern, grammar and central schools Analysis of variance showed that the differences between school types were significant at 1% level for P-scores (boys and girls) and A-scores (boys) and that the differences were in the expected direction Peel and Lambert's ingenious combination of information and 'miniature situation' test for measuring academic Vs technical intersts, to be used in selecting 11 + pupils for different types of secondary schools serves as a corner stone in the measurement of curricular interests.

When Dr Wiseman and Fitzpatrick factorised 'Devon Interest Test' by the centroid method they got 'g' or g . ed in Vernon's notation, as the first factor. The 'g' element in the interest test which is coutaminated with aptitude or achievement is not useful for differentiation In their process of factorisation there emerged a bipolar second order factor It showed + ve loadings on some tests and - ve on others The bipolarity of this 'Interest' factor possessed power to differentiate efficiently, one group of students from another

One of the functions of this predictive battery of eight tests lies in developing optimal differentiation among families of studies-Humanities and Science Hence an inventory on the lines of the 'Devon Interest Test' was constructed An inventory differs from a test, in that there are no right and wrong answers or choices in it. It seeks information about students but does not test their proficiency It yields a score but does not give credits Dr. Wiseman calls his interest test an interest questionnaire also. Therefore, a straight forward questionnaire approach, in which a large number of activities from both Humanities and Science courses are listed, is preferred for this inventory. A student is asked to say which activities he likes to engage in and which he does not. The inventory contains 100 items, fifty from Humanities and fifty from Science course respectively Each box is made up of 5 items, out of which two are Humanities and two Science activities. The fifth item is either a Science or a Humanities activity. This forced choice questionnaire covering two (main) types of curricular interests appears more promising than Strong's or than any simple check list of interests because it eliminates response sets and is easier to standardize and score.

Personality :

Allport describes personality to be the dynamic organisation within an individual of those psychological systems that determine his unique adjustment to this environment. R B Cattell explains personality as a predictor of a person's behaviour in a given situation. Pointing to the comprehensiveness of personality, Morton Prince defines it as 'the sum total of all the biological innate dispositions, impulses, tendencies appetites and instincts of an individual and the dispositions and tendencies acquired by experience' Personality is thought of as related to but not identical with intelligence, and as being closely identified with social ease and emotional balance

Personality refers chiefly to an individual's emotional and social qualities together with his drives even though his intelligence, physique and skills are certainly parts of it Personality is expressed in terms of traits A trait is a characteristic, a trend, a way of response, an attribute or an aspect It is a mental structure, a quality of a person used to describe his life processes how he thinks, feels or acts Because an individual possesses certain traits, interrelated in specific ways he acts in a particular way He has an integrated personality when his perceptions, habits and motives cognitive, conative and affective aspects of behaviour leave their marks in a pattern of personality traits that result in maximally effective adjustment with his environment

Human personality is a complex phenomenon Simon Doniger states · "Human personality is so complex that we know it only in part, here too, we see, through a glass faintly It is impossible for any one to understand a single personality (in its entirety) the pistonlike drives within ; the tension between desire and ideal, the clash of contending attitudes, the tortured effort of a flesh encased spirit to be free and autonomous resulting in a conflict which usually destroys unity of experience and peace of mind" Therefore, its measurement is exceedingly difficult.

In this research we are interested in the revelation of personality of a student of 14 + through his style and form of work, through the steady or spasmodic quality of his adjusment ; through his feeling tones. Personality is dealt with, here, at a non-cognitive level, more or less as a function of emotional integration and personality organisation and is measured by providing behaviour samples and miniature situations of every day life within compass of a student Projective tests which are too lengthy, much too dependent on the subjective judgement of the tester and validity whereof is poor were not suitable to the objective in view in this study

Paper-and pencil tests which can generally be applied to a large sample and scored by slightly trained scorers have therefore, been selected. Prof. Vernon says* "Despite their extreme weaknesses and dangers, paper-and pencil personality tests and questionnaires should not be entirely condemned. Well constructed ones given under suitable motivating conditions can be of value both in educational guidance and for experimental research." Moreover, personality inventories are more worthwhile than projective tests in selection and guidance because of better motivation of students.

The Bernreuter Personality Test (1931) which has achieved enormous popularity in U. S. A. represents a new departure in the measurement of personality in that it measures six different traits at one time. A very considerable saving both in cost and time required for administration is a great advantage of this test when N is large. The scales possess high reliability and permit their being used to compare one individual with another. It has 125 items situations in every day life or samples of behaviour-which are mostly selected from Thurstone's Personality Schedule (1930), Freyd, Heidbreder's Introversion-Extraversion Test and Allport's Ascendance-Submission Reaction study. It measures B1N-Neurotic tendency, B2S - Self sufficiency, B3I-Introversion - extraversion, B4D - Dominance - submission, F1C - Confidence in oneself and F2S Sociability traits.

The personality test :

Flanagan (1935) factorised Bernreuter's original B1N, B2S, B3I and B4 D trait scores and suggested that the same test could measure two other personality traits - confidence in one self (F1C) and Sociability (F2S). Flanagan's results justify the selection of F1C scale in this study even though it is highly related to B1N scale. A personality trait on which many researches of Cattell, Eysenck, Guilford, Pintner have been directed is Neurotic tendency. Bernreuter's B1N factor certainly overlaps with Eysenck's neuroticism factor. Factorial studies of personality questionnaires show that introversion - extraversion overlaps largely with neutrotic tendency. Bernreuter has suggested, also, that B1N is to be preferred over his B3I because it possesses higher reliability (.95). Thus B1N from Bernreuter's four scales and F1C from

---

* Personality Tests and Assessments, P. E. Vernon 1953

Flanagan's further research on Bernreuter scales are selected to measure affective conative personality of 14 + students in this study

B1N gives a measure of neurotic tendency Persons scoring high on this scale tend to be emotionally unstable Those scoring low tend to be very well balanced emotionally

F1C is a measure of confidence in oneself Persons scoring high on this scale tend to be hamperingly self-conscious and to have feelings of inferiority, those scoring low tend to be very well adjusted to their environment

Johnson (1934) has shown that the temporary mood of an individual does not seriously influence test responses in Bernreuter Personality Test This has confirmed the utility of Bernreuter Personality Test beyond doubt

Vernon has pointed out that the judgments of students furnish quite useful information regarding personality trait, but estimates and judgments of those who have observed them in school regularly especially their class-teachers, adds to this information Therefore, class-teacher's ratings of personality of students under their charge are also taken For prediction purposes a faw really reliable measurements of students are more helpful than subjective generalizations about their personalities as a whole, hence, only B1N and F1C sre treated as predictor variables and estimates of teachers are not included In the battery The 'Personality Test' of Dr Bernreuter was translated into Marathi with his kind permission

PREDICTOR VARIABLES

1

Differential measurement at 14 + :

In their second study in 1945 (PMA - SRA, Chicago 1947) the authors of 'Primary Mental Abilities, L L Thurstone have found N V W, S and R factors adequate to measure mental ability at 14 +. Suggesting a closer agreement on a fairly short list of mensurable dimensions of intellective ability Vernon has proposed that all factorists should agree to extract first of all factors corresponding closely to Thurstone's N V, R and S factors. D Wiseman* has discarded S in differential prognosis in the words

> 'The relative lack of success of spatial tests in solving the problem of differentiating abilities and aptitudes required for technical and grammar courses has been due to the fact that such tests appear to measure primarily intelligence-'g' factor - only and secondarily spatial ability"

In his study Dr Varma has shown convincingly that the increment R2 by using his complete battery of eight tests as against the reduced sub-batteries for different criteria is not significant. None of the variance ratios calculated proved a significant increase in R^2. Hence he proposed that the sub-batteries of Differential Scholastic Aptitudes be used advantageously in place of his complete battery. His findings which further justify the selection of only N, V, IR and DR 'Differential Aptitude' tests for this research as shown below are revealing :-

TABLE No 2
DSA SUB-BATTERIES AND CRITERIA

Criterion	Test	R^2	Other tests added	Increment in R^2 after adding the tests,
Language	N V, DR	2461	IR, P M	.0094
Geography	N, V, Fd	.1767	IR, S, M	0076
Science	N V, IR Fd	1865	DR, P, S, M	.0048
Maths	N, V, IR M	3683	DR Fd	.0092

---

* Recent Trends in Psychology, T K N Menon, 1961.

The second study (1941-47) of Thurstone on 710 students of 8th grade has yielded a Second order factor - a 'g' - which is termed by him as 'Central energizing factor' This suggests that a separate intelligence test is not necessary when such a DAT battery is used for differential measurement at 14+ Thurstone is supported by the authors of the DAT in their fifth research of DAT in October 1951.

Prof Vernon has admitted that the main basis of any segregation or selection at 11+, and 11+ selection is a peculiar English institution, must be general intellectual ability because this is what we are, in fact, able to measure at that age. According to him students at 11+ fall into two broad streams representing opposite ends of a continuous distribution, A-academic - verbal and P-technical - practical

Scholastic measurement is a function of both the 'general' factor which gives an index of all-round scholastic ability and Group' factors peculiar to diversified courses of study in IX grade. Burt always insists on the presence of a general factor in addition to the group factors or 'primary abilities' Secondly, Burt emphasized that the 'general factor' common to all 'cognitive' abilities extends to non-cognitive traits also, and that it is, therefore, logically desirable to include assessments of emotional and conative characteristics The measurement at 14+ has firstly to determine the preferable stream of study for a pupil and secondly his probable success in that field of study. The multipotentiality of 'Group' factors, by virtue of which the components of a test battery are free to combine variously, resulting in maximising differences is of great value at 14+. Since differential selection of students for diversified courses of study and differential prediction of their scholastic success are the objectives of this research the multivariate approach to scholastic measurement has been used.

The DSA Sub-battery of this study :

In view of the above trends in the fields of aptitude testing and differential prediction, only N, V, IR and DR factor tests from Dr Varma's battery of 'Differential Scholastic Aptitudes' are selected to measure scholastic aptitude and to predict scholastic achievement of pupils(14+) in secondary schools of Vidarbha As regards the functional importance of the above tests N is an index of computational skill and emphasizes speed IR is a 'power' function and is a good index of intellectual level and V and partly DR show linguistic attainment, specially V which depends on the vocabulary acquired

This sub-battery compares favourably with similar sub-batteries of the PMA and Dr Varma's reduced DSA battery The inter correlations (reported to two decimal places only) of the factor tests are -

TABLE No 2 1

COMPARISON OF IDSA SUB BATTERIES

Dr Varma s battery IX graders, N = 623				This battery IX graders N 753				Thurstou's battery VIII graders, N = 710			
	V	IR	DR		V	IR	DR		W	V	R
N	25	27	16	N	32	35	14	N	41	40	53
V		32	25	V		42	38	W		54	.49
IR			14	IR			16	V			.59

Interest Measures :

Measuremen of interest has been helpful in determining the direction of future scholastic performance of students in solving the problem 'what track next ?' Fryer based his measurement of interest on expressed interest, i e the verbal profession of interest in an object, activity, task or occupation He measured Interest in specific subjects of curricula and reported correlation of 60 between interest and ability and 30 between interest and achievement Thorndike attempted to determine how far the degree of a student s interest in each of a variety of school subjects was associated with a corresponding degree of academic success in the same subject His value of r (89) was too high Testing the validity of Thorndike s experiment Bridges and Dollinger correlated interests with the grades actually received and the r was .26 only This investigation indicates that the relation between interest and achievement while low and less [illegible] formerly [illegible], Bendin found correlation of .43 between [illegible] honour point ratio [illegible] curriculum satisfaction scores

Garretson attempted to measure academic technical or commercial interest of secondary school boys through subject preferences His data indicate that ninth grade students can be differentiated on the basis of interests among three curricula-

Commerce, Academic and Technical. His scores on these interest scales correlate with corresponding school grades as :

TABLE No 2 2
CORRELATIONS BETWEEN INTEREST AND SUBJECT PREFERENCES

Technical	Academic	Commerce
29	15	03

Correlations of 25, 13 and .03 respectively were reported between interest measures on the literary scale of the Kuder Preference Record and grades in English, History and Science Dr Wiseman worked on inter-correlations between achievement academic interest (A) and practical interest (P) for the age group 13 +

TABLE No 2 3
CORRELATIONS BETWEEN INTEREST AND GRADES

	Devon P	Devon A
English	— 036	.139
Arithmetic	— 019	— .055
Devon P		— 55

The values obtained in this study (age group 14+) are

TABLE No 2 4
CORRELATION BETWEN INTEREST AND SCHOOL MARKS

	Sc Int	Hu Int
Achievement	— 02	02
Sc Int		— 41

The negative correlation to the extent of .55 between Devon P and Devon A reported by Dr. Wiseman and of 41 between Sc Int and Hu Int obtained in this research prove the bipolarity of curricular interest which possesses power to differentiate efficiently, one group of students from another

The Interest Inventory :

On the lines of the Devon Interest Test interest activities were selected on the basis of data from school books, interviews with students and teachers and question papers. They were critically analysed firstly by subject teachers and secondly by the researcher himself, after a pilot test had been given to 106 students not concerned with the main testing.

A preliminary pool of 125 items from Humanities and Science courses was administered to 100 teachers - 50 teaching Humanities and the others teaching science subjects The responses were on a five point scale classifying each item as- Humanities, Science, Both, Neither or Irrelevant Percentage - weights of all items (125) were calculated The item-weights equal to the percentages of response to each item, hence such a scoring system is called the 'percentage weight' system The percentage-weight scale of above measures the degree to which one has the interests most typical of members of either Science or of Humanities group These weights were transformed into unit-weights ranging from 1-9

Ream had developed a method of scoring an interest test His method is based upon objective criteria The standard error of the difference between the percentages of the two classifications for cach items was calculated as suggested by Ream *

$$SEP_D = \frac{D}{6D} = \frac{P_1 - P_2}{6(P_1 - P_2)} = \frac{P_1 - P_2}{\sqrt{\frac{P_1 Q_1}{N_1} + \frac{P_2 Q_2}{N_2}}}$$

Whenever the SEP_D equaled or exceeded the C. R where C R. is 2 58 at 1% level of confidence, the item was given a weight of 1 After following Ream's procedure Freyd has suggested that an item be given a weight of 1 even when the C R equals or exceeds 2 Rock and Wesman reported practically no difference in amount of differentiation resulting from use of the C. R and the correlational procedures used by Cowdery Kelley and Strong Items which equaled or exceeded 2 were retained

A few items needed redrafting and were accepted only after a fresh try-out. All other items were rejected The selected 100 items together form one item pool for further treatment (Appendix E)

The item-pool (100 items) is administered to a check-sample of 200 students (80 belonging to Humanities and 120 to Science group) of Class IX and item-weights on a two point scale - Humanities or Science - calculated as stated above Teacher-weights of these items are verified by student-weights and surprisingly only in one case (item No 67)

SEP_D of students is less than 2 while that of the teachers is 3 45 Item No 95 is retained because of the heavy weightage (12 24) given to it by students even though the C. R of teachers is 1 90 A testee is suggested to choose between items representing two opposite fields of study in a box of five items according to his liking

Scoring interests differs from scoring ability or achievement tests, in that there are no inherently right or wrong responses to interest items as there are in ability or achievement tests It is necessary at the very beginning to set up some standard as to what are acceptably right and wrong interests It is logical to accept the responses of science students alone as the basis for right and wrong responses for science interest and of Humanities students for Humanities interest when similarities are to be considered Scoring of test items is done on the basis of student-weights on a five point scale-Like most, like, Indifferent, Dislike, Dislike most. An item - response of a student in the correct direction, is given a score of 1 A wrong response (including Indifferent) carries a zero. After adding all the correct item-responses two interest scores - Humanities Interest score and a Science Interest score - separately for each student are obtained for all the students (N = 640)

Measures of B1N and F1C traits :

Kelly sought to determine the relative part contributed by intelligence (capacity) and personality (industry) in determining scholastic success as measured by the average mark at the end of first year of high schools Burt and Alexander recommended :

> "An ideal scheme of selection of students for secondary schools cannot rest solely on assessments or tests of intellectual qualities, but must have due regard to qualities of temperament and personality - 'persistence' and 'stability' factors described by Burt "

Yates and Pidgeon have proved that neuroticism (B1N) possesses a facilitating effect and motivates sustained learning. That personality shapes scholastic achievement independently of cognitives has been declared by Broadbent and Astington

The personality traits are regarded as relatively permanent dispositions consistently revealed in a variety of characteristic behaviours They are bipolar and students can be arranged along a behaviour continuum

Dr Bernreuter's B1N Scale is identical with Thurstone's Neurotic Inventory(TN) which is a previously validated test The weights on the scoring key of B1N were computed on the basis of the extent to which each question differentiated between criterion groups composed of individuals who possessed the two traits to an extreme degree.

Flanagan factorised Dr Bernreuter's Personality test scores on the four traits and suggested that (F1C and F2S) two independent measures could be derived from the same inventory The first factor (F1C) extracted, accounts for 78 percent of the total variance of all the factors The second factor (F2S) - Sociability - accounts for only 18% of tha total variance Out of the two only F1C is preferred because of its larger variance (78%)

On administration of his B1N and F1C scales on high school students Dr. Bernreuter got the following measures for central tendency and dispersion :-

TABLE No 2 5
BERNREUTER S MEASURES OF CENTRAL TENDENCY

	High School Boys			High School Girls		
	N	M	S. D	N	M	S D
B1N	145	-60 2	75 4	121	-22 9	78 2
F1C	200	-14 5	92 8			

The measures for sub-samples - boys and girls - of this study are calculated to compare with those of Dr Bernreuter.

The values of M and S D. in this study are :-

	High School Boys			High School girls		
	N	M	S. D	N	M	S D.
B1N	381	27 47	54 685	259	- 15 731	55 17
F1C	381	- 4 555	54 678	259	13 031	62 193

The correlation between B1N and F1C scales is 8595 Even though B1N and F1C are highly +vely correlated they are included in the battery for the simple reason that B1N shows the temperamental disposition in favour of or against a course of study and F1C indicates sticking to the selected course of study and desire to achieve better success in it consequently In both the results girls appear to be less neurotic - more emotionally stable - than boys It is assumed that there are significant differences in the personality make - ups of students. The scores on the B1N and F1C scales are correlated with scaled marks in essay - examinations of the above students

The values of r are .-

(N = 640)

F1C and Achievement	B1N and Achievement
1167	1307

In an intensive study of grammar school entrants Astington reports the following correlations between ratings of persistence, independence and other qualities and the achievement indices, for them at the end of academic year.

1957 INTAKE - N = 54 (Age 14+)

Achievement Index and Personality ratings 262

1958 Intake - N = 51 (Age 14+)

Achievement Index and Personality ratings 218

It is clear from the above results that when measures of personality traits are correlated with achievement indices the values of r are generally low

Teachers's estimates of personality :

With a view to introducing teachers to the new concept of evaluation and the place of their judgments in evaluating students' progress, class-teachers were requested to give their estimates of ten personality traits - initiative, Integrity, Persistence, Leadership, Self-confidence, Emotional stability, Sociability, Seriousness of purpose, Security and Industry on a five-point scale of the students under their charge

The estimates were brought to a common scale The values of r between scaled estimates of personality of students by teachers Personality measures of F1C and B1N traits and Achievement are .

TABLE No 2 6

RELATIONSHIP BETWEEN ESTIMATES OF PERSONALITY AND PERSONALITY TRAITS AND THE CRITERION

Scaled estimates of Personality and F1C r = 0913

— do — and B1N r = 0937

— do — and Achievement r = 4242

The comparatively higher value of r between teachers' estimates of personality and scholastic achievement reveals that the estimates are highly contaminated with scholastic progress, i e. placing teachers' judgments about better students (intellectually) at the better end of the traits and vice versa Therefore these estimates were not included in the predictive battery

The procedure :

The DSA sub-battery (N, V, IR and DR tests) was administered to 758 students of Class IX of 12 Secondary Schools in the Vidarbha region of Maharashtra Majority of the schools are co educational. Four admit girl students only In some, only boys preferred the science course. Ten schools located in different parts of Nagpur and two from rural areas (one from Morshi Amravati district and the other from Saoner, Nagpur district) were selected for administration of the tests Generrally a section each from Humanities and Science courses out of many in big schools were considered

The time taken for the complete administration of the four tests was 84 minutes - (N-12', V-20,' IR-40' and DR-12')

The 'Interest Inventory' and the 'Personality test' were administered in the same schools after six months The time taken for administration of these tests was two periods each of 40 minutes duration Students absenting themselves from a single test led to reduced N (640) for further treatment School ma ks of all the examinations of Class IX in diversified subjects were collected Subject teachers' estimates of Scholastic Achievement of these students in the above subjects were obtained They were given normalized frequencies on a ten-point scale and were requested to assign symbols for the porgress of a student in a subject which was taught throughout the session Class teachers' estimates of personality of their students of ten common traits of personality were obtained on a five-point scale In order that one's opinion should not be coloured due to some impression formed about a pupil regarding his ability in some other subject or activity personal discussions were held with teachers. The work of administration of tests had to be slow and it was completed in two years

The Age group :

The distribution of age (15 05) appears to be normal for Class IX because a student after being admitted at 6+ into a primary school, has to undergo eight years (6+ to 14+) of general education before he is admitted into a secondary school

Age .	General (N=758)	Boys (458)	Girls (300)
	M = 15.05	M = 15 5	M = 14 38
	S D = 1 38	S D = 1 35	S D = 1 14

The dispersion in age of boys (1 35) is greater than that of girls (1 14) It reveals that the percentage of failures resulting into stagnation is greater with boys than that with girls The means, 15 5 for boys and 14 38 for girls, support this The tendency for age to scatter more widely due to failure is harmful It is one of the main draw-backs of our system of education. Girls as a class appear to be younger than boys and stagnation in their case is less than that with boys The immediate object of testing in class IX is to diagnose differential scholastic aptitudes, interest and personality of students for offering a suitable course of study and to predict chances of scholastic success in the course of study offered on the basis of aptitude, interest and personality measures

The criterion :

Marks obtained by students in essay-type examinations is the only criterion available in India as it was the case in England before 1930. However accurately the data obtained through essay-type examinations reflect the individual's retention of what he has already studied, they often fail to suggest his promise for other fields to which he has not been exposed.

Alarmingly, the unreliability of the 'pass mark', i. e , the pass-stamp on a student even though he gets 33% marks only makes matters worse. This unscientific method has created a situation where too little ability and that too of the memoriter class only, is chasing too high an academic standard. A student's strongest intellectual powers may be latent and as yet uncultivated through lack of recognition or opportunity Marks in essay-type examinations being the only criterion, they, with all the limitations, have to be employed for placement or differential prognostic uses in our country.

Why Humanities and Science ?

Multipurpose Higher Secondary Curricula - the seven diversified streams - were introduced in eight Government High Schools by the then Madhya Pradesh Government in 1955-56 The first public examination (H. S S L C) was held in March 1958 Fifty-seven non-Government high schools of the Vidarbha region of Maharashtra (after the States Reorganisation), instituted diversified courses in July 1958. The number of such schools went on increasing The 'Fact Finding Committee' appointed by the Vidarbha Board of Secondary Education observed in 1959 that out of 98 Higher Secondary Schools in Vidarbha 96 had offered Humanities and Science courses Their findings are :-

Diversified Groups.	Hu	Sc	Agri.	Tech.	Comm	H Sc	Fine Arts
No of Schools offering the group	96	97	15	6	21	11	9

Humanities and Science are the major streams provided by schools and (probably for that compelling reason) opted by students When 76% schools offered these courses and when more than 80% students were admitted into these schools it was in the fitness of things to select these streams for this differential study

Burt has pointed out the difference in cognitive personality in respect of Humanities and Science interest Researches on selection of students for secondary education have proved that these are the two broad streams that split off at the end of general education The American Council Psychological Examination provides two major indices of students depicting the two streams from the scores of them on six PMA tests and a general intelligence test One of them appears to be Q - Quantitative Index indicating Biological and Physical Sciences stream and the other is L - Linguistic Index denoting Humanities and Social Science stream Dr Alexander distinguishes between V - Verbal and P - Practical types of ability for 11 + students. Crabb has suggested humanistic realistic and practical as the three groups of subjects for secondary school entrants at 12. In Vernon's notations these streams are described as V . ed. - Verbal - educational and K : M - Spatial - mechanical

Evaluation :

Education is a continuous and life long process Evaluation is an attempt to discover the extent of the effectiveness of learning in invoking the desired changes in students. It is necessary to determine the status of a student at the starting point At periodical intervals evaluations have to be made and changes identified in comparison with a student's position at the starting point

Laying the foundation of the evaluation movement the world war II accelerated the construction and large-scale administration of aptitude, mental ability and situational tests, personality instruments, interest inventories, interviews, observation and many other tools of measurement Interest in the measurement of mental ability (Binet's intelligence test of 1904) at turn of the twentieth century has grown into an interest in the measurement and evaluation of the many different variables that make up human behaviour.

Teachers' Estimates of achievement :

Instead of the performance examination period rated by essay-type Examination, teachers' judgments are based on the performance or scholastic achievement of their students over a year Estimates reflect performance under normal conditions where as examination is taken under considerable strain

The prime defect of estimates is that they represent crystalized emotional attitudes of the raters towards the ratees, even when the rating scales attempt to emphasize observed behaviour. Teachers tend to over-estimate the attainments of the weak students and under-estimate those of the good students This decreases the weight given to their estimates when they are combined with other measures The standard of these estimates varies considerably from school to school and this lowers the correlation considerably.

A uniform marking plan or grading for achievement was emphasized in this study Teachers were instructed as to how estimates should be given on a ten-point scale. These were taken in categories - A, B, C, D, E, F, G, H, I and J. The significance of each category was made clear and the precentage of a normal class falling into these categories was indicated in the proforma of instructions as shown below.

TABLE No 2.7

CATEGORIES AND NORMALIZED FREQUENCIES

Marks	90-99	80-89	70-79	60-69	50-59
Categories	A	B	C	D	E
Normalized frequencies	1	3	8	14	24

Marks	40-49	30-39	20-29	10-19	0-9
Categories	F	G	H	I	J
Normalized frequencies	24	14	8	3	1

Scaling of Scores :

The norms and dispersions of the scores on the predictor variables or the essay-type examination marks are not directly comparable A single overall test which can be adminstered to all the testees is needed to determine the most probable group means and group standard deviations. The scores and marks need to be transformed in such a way that the mean and standard deviation of the transformed scores and marks for any school will proportionately be the same as the mean and standard deviation of the scores and marks of the students of that school in a uniform test. The uniform test score used is a composite score of the aptitude tests - N, V, IR and DR - administered to all the students.

Scores and marks are reduced to comparability by scaling by the following method which essentially is a linear transformation of all marks to a scale that has the same mean and standard deviation as a composite of the aptitude test scores

The formula used for scaling is :

$$Ts = Mt - \frac{6\,t}{6\,E} \quad (X - ME)$$

The mean of uniform test is 28 97 and the 6 is 5 875

Ts - Scaled score or mark

Mt - Mean of the uniform test

6 t - Standard deviation of the uniform test
6 E - Standard deviation of scores or marks of students
X - Score or school marks of a student
ME - Mean of scores or marks of students in a school

In the following table are shown the means and 6s of school marks in examinations and the procedure by which they are brought to a common scale -

TABLE No 2 8
COMPARABILITY SCALE

	Schools	Means	S D	Scaled Scores
1	New English Main	36 1	12 32	48X + 11 75
2	Hindu Mulinchi	36.76	11.10	53X + 9 76
3	C P and Berar	40 99	11 56	.51X + 8 14
4	Dhanwate	35 46	10 25	57X + 8 66
5	Lokanchi	39 90	9.63	.61X + 4 63
6	Saoner	42 89	10.28	57X + 4 52
7.	Shivaji	56 65	13 28	43X + 4 61
8	Hadas	32 41	12 99	45X + 14 39
9	New English Bardi	46 60	12 07	49X + 4 13
10.	Somalwar	45 19	18.55	.32X + 14 51
11	Dharampeth	41 86	8 50	69X + .09
12	Bhide Kanya	48.48	14 42	41X + 9 09

Class teachers' estimates of personality were brought to a common scale also However, Teachers' estimates of achivement and personality of their students are not included in the predictive battery

PARAMETERS AND FUNCTIONS 2

Test Reliability :

The sample of 640 students of class IX is employed to represent the population - students of class IX of secondary schools - in the Vidarbha region of Maharashtra The sample statistics Mean, σ r etc., estimate the hypothetical population parameters on eight variables - N V, IR, DR, Hu Int., Sc Int, B1N and F1C of the battery and the criterion

This study aims at selection of students for diversified courses of study and prediction of scholastic achievement of students of class IX in science and Humanity groups, mainly, on the basis of eight variables of the predictive battery

The reliabilities of the tests in the battery are -

TABLE No 3 1

CO-EFFICIENTS AND INDICES OF RELIABILITY OF TESTS

N = 640

	Coefficient	Index	Method
N	73	85	Test-Retest
V	70	84	KR
IR	93	96	KR
DR	60	77	Alternate form
Hu Int	93	96	- do -
Sc Int	95	97	- do -
B1N	91	95	Split half
F1C	86	92	- do -

Reliability of the Interest Inventory :

Because a re-test coefficient of correlation does not tell us any thing concerning the internal consistency it is not worked out for the Interest Inventory' The alternate forms method resembles both the internal consistency and retest methods It gives an index of how equivalent the contest of one form of the test is to that of the other It indicates both equivalence of contests and stability of measurement For establishing the reliability of the inventory the responses of teachers (N = 100) are used. The 'Inventory' is divided into two parts, equally Both the forms are rated separately by science teachers (50) and Humanities teachers (50)

The values are -

TABLE No 3 2

RELIABILITY OF INTEREST INVENTORY

Interest items	Mean teacher weights	Coeff of Reliability	Index of Reliability
Humanities interest	39 8	93	96
Science - interest	36 8	.95	97

Standard errors of Sample Statistics :

Standard errors of sample statistics were found They indicate the reliability of the obtained statistics as estimates of the corresponding population parameters

TABLE No 3 3

SE OF CENTRAL TENDENCIES AND DISPERSIONS

N = 640

	Variables								
Statistics	N	V	IR	DR	Hu Int.	Sc Int	B1N	F1C	Cri Ach.
M	28.39	25 92	21.94	39 34	34 59	42.44	-22 72	2 56	28 93
SEM	.40	.34	36	.20	.51	54	2 18	2 31	23
6	10 09	8.72	9 2	5 05	12 98	13 58	55 13	58 48	5 91
SE 6	28	.24	26	.14	.36	.38	1 55	1.64	.17

Because the standard errors of sample statitistics are very small, we can safely trust the obtained statistics as good representatives of the population parameters

SE Coefficients of correlation :

Like M and 6 *the r is subject to errors of sampling* The SE of r and knowledge of the form of distribution in which the sample 'r's fluctuate around the population r are required to estimate its deviation. Since the sample is sufficiently large (N = 640) and the obtained r's sufficiently removed from the extreme regions of 1 and -1, where skewness can be encounterred we can trust without much risk that the distribution is symmetrical The properties of the normal curve in order to estimate the limits of fluctuation on the basis of σ_r deviations, at various fiduciary limits, viz 5% or 1% can, thus be used

In finding SE of r, it is converted into Fisher's z. Upto an r of .25 z and r are approximately equal. Even, when r = .50, z is not larger than .56. Within the limits from -.50 to + .50, then, distributions of r are essentialy normal, if N is not too small Guilford has suggested that beyond this range, when normal distributions are important, it is desirable to convert r to z For values of r falling in the range - .50 to + .50 the general formula -

$$\sigma_r = \frac{1 - r^2}{\sqrt{N-1}} \text{ is applied}$$

TABLE No 3 4

THE VALUES OF SEs OF 'r' S

	variables							
	V	IR	DR	Hu Int	Sc Int	B1N	F1C	Cri Ach
N	00370	00366	00387	00390	00381	00383	00395	00376
V		00354	00362	00391	00384	00389	.00390	00372
IR			00386	00391	00384	00389	00390	00370
DR				00390	00390	00389	.00390	00386
Hu Int					00357	00388	00389	.00391
Sc Int						.00388	00387	.00391
B1N							.00799	00387
F1C								00388

Thus, it can safely be declared that the inter-test correlations of the variables of the sample and the criterion represent population parameters with very small margins of error.

SE of Differential statistics :

In practice, we have to compare measured results under two conditions that are arbitrarily set up, viz the general sample of students and Humanities or Science students of this study respectively Therefore, of much more practical value than the SE of sample statistics are the the SE of difference between statistics of these sub-groups and the sample The null hypothesis, here, is the supposition that in the population from which the samples are drawn, there are no real differences between the sample statistics and population parameters and the two sub-group statistics arise by random sampling from the samples population, i e,, the two groups from which the two sub-samples are drawn are obviously different in other respects

To test the significance of differences between the sample mean (M) and the means of the sub-grougs (MHu., MSc) the critical ratio (E) technique is employed The C R or the statistic $\bar{z}$ is the ratio between difference between statistics (M, 6 or r) and the SE of this difference

TABLE No 3 5

THE REPORTED VALUES OF $\bar{z}$

	Variables			
Sub-groups	N	V	IR	DR
$\bar{z}$ (Hu)	(-6)	(-9 85)	(-4 22)	(- 39)
$\bar{z}$ (Sc)	5.435	3 77	3 9	36

Sub-groups	Hu Int	Sc Int	B1N	F1C	Ach
$\bar{z}$ (Hu)	5 12	(-8 92)	(-2 38)	(-1 72)	65
$\bar{z}$ (Sc)	(-4 35)	8 07	2.15	1.65	(- 55)

When N is large, the distribution of C. R. s is regarded to be normal around the population difference. Hence in testing the null-hypothesis which denies the existence of any difference between population mean and the sub-group means and attributes the observed differences to accidental errors, it is required to seek whether or not the C R s exceed 2.58 or 1 96 so as to ensure their significance at 1% or 5% levels of confidence when one is interested in the existence of such differences in absolute terms. In this study the interest lies in the direction of the differences (marked by + and - signs in the table) also.

On consulting table D p 449, Garrett we find that 10 percent of cases lie to the left and right of 1 65 so that 5 percent (P/2) lie to the left or right Therefore, all C R s above this value are significant at 05 level of confidence. In all such cases we reject the null hypothesis since only once in 20 trials would a gain or a loss equal to observed magnitude will occur over the total mean In the same table we find that the C R values equal to or greater than 2 33 is significant at 2 % level (P = 02) Hence an observed '+' or '—' difference between means will be regarded as significant at 1 % level of confidence

On the basis of these considerations the following table has been set-up It indicates whether the measures of central tendency of the sub groups are significantly greater than those of the sample on the variables and the criterion, at p = 05 and p= 01 levels of confidence

TABLE No 3 6

SE OF DIFFERENTIAL MEANS

	(MHu — M)		(MSc — M)	
	p = 05	p = 01	p = 0 05	p = 01
N	Yes	Yes	Yes	Yes
V	Yes	Yes	Yes	Yes
IR	Yes	Yes	Yes	Yes
DR	No	No	No	No
Hu Int	Yes	Yes	Yes	Yes
Sc Int	Yes	Yes	Yes	Yes
B1N	Yes	Yes	Yes	No
F1C	Yes	No	Yes	No
Ach	No	No	No	No

It is established from the directions of differences between sub group means and the sample mean that there are significant differences in abilities and traits possessed by pupils forming these sub-groups, Humanities and Science The values of C R s show that the sub-groups differ significantly from the sample in their measures on the independent variables only (excepting DR).

It was attempted to compare the sub-groups directly and their differential measures of central tendency and dispersion are caluated to facilitate interpretation of test results later.

Validity :

From the practical standpoint, the validity of a test as applicable in this study is its forecasting efficiency or predictive power - the degree to which test scores predict criterion measures This practical or predictive validity is dependent upon common factors in the test and the criterion

One of the most difficult of all aspects of the validity problem is that of obtaining an adequate measure for the criterion The criterion (scholastic achievement) is most difficult to measure adequately School marks as ordinarily assigned by teachers are a fallible criterion and are rather poor metric material

The validities of N, V, IR, DR are reported by Dr Varma in *his studies* as follows. Validities of Interest Inventoris : B1N and F1C are worked out

TABLE No 3 7

CO-EFFICIENTS OF VALIDITY

Tests	N	V	IR	DR	B1N	F1C	Hu. Int	Sc Int
Coeffi-cients.	85	84	96	77	.95	.92	.83	.87

The validities of Humanities and Science item-pools in the 'Interest Inventory' are obtained by comparing approximately the upper and lower 27% of the total group Kelley, Strong and others have supported this The Coefficients of validity are -

	VALIDITY
Humanities items	.83
Science items	87

Fitzpatrick and Wiseman have reported the following validities of Devon P (Practical Interest) and Devon A (Academic Interest) drafts of the Devon interest Test.

	P	A
Boys	.91	.88
Girls	.90	.80

The predictive validity of the complete battery against the criterion is reported in Chapter III

Factorisation of Variables of the battery :

The cognitive and non-cognitive areas - Interest, Aptitude and Personality - influencing scholastic achievment of students are decided upon already for this study. Therefore factorisation of eight variables, from the above three areas of the battery is not so necessary because the factors would synchronise with the areas Thomson had pointed out that the extraction of factors from the tests in a battery might prove to be an unnecessary intermediate step when tests were given with the object of predicting a criterion.

But researches on prediction and especially those of Burt Stephenson, Thurstone Cattell and Vernon have shown that the process of factorisation should be utilised when scholastic achievement is to be predicted and students are to be selected for different educational courses

Moreover, the modern tendency as regards validation of a battery is to factorise the variables in it Therefore, the intention of undertaking factorisation of the variables was to verify the integral independent nature of them and to study the differential contributions of the variables to the team (Interest Aptitude and Personality) of determiners of scholastic achievement

Harman had advocated utility of the centroid method when electronic computing facilities are not available He stressed that the centroid method provided an efficient compromise to the principal factor method for a small matrice of correlations

The variables in the predictive battery of this study being eight only the centroid method is followed The matrix of inter correlations among the eight variables is factorised firstly by the centroid method (Thurstone) Numerical Ability is selected for the pivot because of its higher correlations with other tests Humanities interest vector has to be reflected before the first factor is extracted

TABLE No 3 8
FACTORS AND FACTOR LOADINGS

Tests	Factors I	II	III	IV
N	4763	- 1856	- 1316	- 2244
IR	4527	- 2991	- 2609	- 2378
V	5013	- 3846	- 3392	1545
Sc Int	4577	- 2591	4394	-.1044
B1N	6454	6676	- 0006	- 0601
F1C	6002	6977	0019	-.0739
DR	3251	- 1327	-.2879	.3313
Hu Int	.-2818	-.1096	5729	- 0825

The maximum number of factors which can be determined by n variables is givan by -

$$r = \frac{2n+1-\sqrt{8n+1}}{2}$$

This comes to 4 5 Therefore, the extraction of factors is continued upto the calculation of the fourth factor and its residuals. Whether further factorisation is worthwhile is tested by McNemar's formula :-

$$6_{\text{A}} = \text{or } \frac{1}{\sqrt{N}} \qquad \text{where } 6_{\text{I}} = \frac{6_s}{(1-Mu^2)}$$

6_s - 6 of the residuals after four factors

Mu^2 - mean communality for s factors.

The coefficients given in the table are the "saturations" of these tests with each of the factors, i e, they are the correlations believed to exist between the tests and these factors respectively

The sum of the squares of the common factor loadings gives the 'Communality' of the test Medland estimated communalities by nine methods on a 63 variable correlation matrix He compared this communality estimates with those computed by the 'centroid' method Seven rounds of calculations leading to the fourth factor residuals are carried out to to stabilize the communalities.

TABLE No 3.9
COMMUNALITIES AND SPECIFIC VARIANCES

Tests	Communalities. h^2	N	IR	V	Sc.Int	B1N	F1C	DR	Hu Int
		Specific variances							
N	.3290	6710							
IR	4190		.5810						
V	.5381			4619					
Sc Int	.4806				.5194				
B1N	.8658					.1342			
F1C	.8525						1475		
DR	3317							.6683	
Hu Int	4264								.5736

To check the centroid loadings the cross-products of the loadings of each variable with its neighbouring variable are calculated The fourth factor loadings and residuals are checked by a method suggested by Fruchter.

TABLE No. 3 9-1
CHECKING THE CENTROID LOADINGS

Tests	Sum of Gross-products	Residuals (IV Factor)	Original correlation
N-IR	.3589	-.0087	.3501
IR-V	.3938	.0274	.4212
V-Sc. Int.	.1641	0192	.1833
Sc Int -B1N	1164	.0024	.1188
B1N - F1C	.8488	.0107	.8595
F1C - DR	.0437	0185	0622
DR - Hu Int	- 0095	0247	0152
Hu Int	- 0606	.0008	-.0598

REFLECTIONS

Before I Factor	I Factor Residuals	II Factor Residuals	III Factor Residuals	IV Factor Residuals
Hu Int	F1C	Hu Int	DR	IR
-.2818	6977	5729	.3313	.2068

The Four Factors :

In this battery of eight predictor variables, there is one underlying factor which has positive weight in respect of every test except Humanities interest, while other factors show great variance with respect to differant sub-divisions of rhe battery namely, Interest, Aptitude and Personality

Whatever meaning a factor has, it is attached to it sub-subsequently through subjective judgment and inspection of what it seems to possess

I The *first factor* shows heaviest loadings on B1N (Neurotic tendency) and F1C (Confidence) and is turned into a bi - polar factor because of its -ve loading on Humanities Interest only. The most noticeable feature of the unrotated loadings is fhe dichotomy of curricular interests Burt had suspected such a dichotomy depending upon the curricular or content diversity.

The first factor weighted by personality characteristics like general balance of emotionality and self confidence combined with general cognitive functions which form the basis of that confidence and balance, can best be described as a general power factor and be named as *'General Scholastic Temperament'*. Humanities interest reflects rule of heart, excitement and fantacy Because it shows emotional instability and lack of confidence in scholastic pursuits it goes opposite to B1N and F1C personality traits. It is at complete variance with Science interest which depicts rule of realism, objectivity and tendency to discover truth. It is negatively correlated to cognitive abilities (N, V, IR) excepting to DR ability The negative loading of Humanities interest on the first factor therefore, indicates lesser inclination for scholastic pursuits of those who possess more of Humanities interest The diversity of 'scholastic Temperament' in respect of Humanities and Science courses justifies their introduction in secondary schools to meet the corresponding diversity of student nature.

The residual correlations after the general factor yield a special kind of pattern which is 'bipolar'.

II. The *Second factor* is *Personality* (non-Intellective factor). The negative pole draws together both academic interest and cognitive abilities It contrasts the non-intellective dynamic side of mind with the variables represented by cognitive functions and their effects on formation of interests

(+)	(—)
B1N F1C	(N, IR, DR, V Abilities Humanities Interest Science Interest)

Neurotic tendency which has emotional stability as the + ve end and Confidence are essential for any pursuit in life and necessarily for scholastic pursuits The ever expanding universe of knowledge and the diversity of streams through which this knowledge could be imparted to students demand greater confidence and emotional stability on the part of students to receive and digest it in accordance with their personality make ups The emotional aspect of mind (Personality) is contrasted with the Differential Aptitudes and curricular interests i e with the cognitive aspect of mind

III Personality variables are neutralised in the *third factor* Interests are contrasted with cognitive abilities The loadings of interest variables on the third factor suggest that curricular interests are stabilised at the age of 14 + and can be measured Strong, Super, Wiseman and others had proposed this already

The third factor can be named as *'Curricular interest'* factor

+	
Science Interest Humanities Interest (Curricular)	N, V IR and DR abilities (Cognitive)

The lower loading of Science interest on this factor than Humanities interest indicates that those who opt for Science (on the basis of VIII class achievement as at present) form a heterogeneous group consisting of some students not possessing adequate Science interest

IV It is rather difficult to name the *fourth factor* The factor-loadings other than of DR and V at the + ve end and IR and N at the - ve end are too small The factor-loadings of DR and V which are positive are also small

This factor only suggests Verbal and Concrete Reasoning as contrasted with Numerical and Abstract Reasoning

+ ve	— ve
V, DR	N, IR

Factor - variances :

The amount which each factor contributes to the variance of a test is indicated by the square of its loading in that test The variances indicate the relative importance of variables Factor variances in this study cluster into two divisions, one contributed by a common source of variation and the other, residual variances contributed by bi-polar factors as given in the table.

TABLE No 3 9-2

FACTOR - VARIANCES

	Factors			
Tests	I	II	III	IV
N	2268	- 0344	- 0173	- 0503
V	2513	- 1479	-.1149	.0239
IR	2049	- 0894	- 0681	- 0575
DR	.1057	- 0334	- 0829	1096
Hu Int.	- 0794	-.0119	3283	-.0068
Sc Int	2094	- 0671	1932	-.0109
B1N	4165	4457	—	-.0036
F1C	3602	4868	—	- 0055
Variances	68%	22%	9 50%	nearly zero
Factors	General Scholastic Temperament	Personality (non-intellective)	Curricular or acquired Interest	

The first factor (General Scholastic Temperament) contributes 68% of the total variance contributed by the factors to the eight variables of the battery This (first) Centroid factor accounts for the largest percentage of variance naturally. It is weighted by emotional stability and self-confidence in scholastic pursuits, is combind with general intellective functions and indicates bipolarity of curricular interests.

The Second factor (Personality) which is non-intellective is contributing 22%, of the variance to the battery. This stresses the importance of measurement of emotional aspect of mind in secondary schools

The third factor (Curricular Interests) subscribes 9.5% of the total variance to the battery.

The eight variables in the battery are grouped into Aptitude Interest and Personality areas. It was evident to the researcher that after factorisation of the variables the factors would synchronise with these areas. It was intended to see whether a general factor would emerge after factorisation of the variables. Moreover, the researcher's interest was in the relative contributions in form of variances of factors to the total variance and in factor loadings of the tests on tests on the factors and their respective signs indicating directions. These relative contributions underlined relative importtance of both tests and factors for prediction of scholastic success.

According to Kelly intellective ability (capacity) and personality (industry) contributed to scholastic success in the proportion of 60 to 40 respectively. May reported that capacity and industry should receive weights in the proportion of total variance and in factor loadings of the tests on Ability (50%), Personality (35%) and chance or accident (15%) as the determiners of individual sucess

Factor analysis of the variables in the battery proves that the battery can profitably be used for differential measurement. The factor-variances give additional insight into the degree of independence and nature of realationship between tests of intellective ability and those of personality and interest - the non-intellective traits. While, the battery is intended to measure both intellective and non-intellective traits together, the criterion - school marks in essay-type examinations - is not only fallible but is capable of chasing a limited intellective ability only. This has limited the scope of this study. This becomes clear when proportions of the total variance contributed by the independent variables in the battery individually, to the composite are calculated with the help of multiple regression equations (Please refer to Ch, III), The assessment of the non-cognitive mind has, thus proved to be very fruitful. Prof Murray actually calls this kind of approach adopted by Prof. Stern, Stein, Bloom and others as the sixth phase of development in the history of Psychological measurement as is the E S. P. or the 'sixth' sense in Abnormal psychology.

Rotation of factors :

The eight variables of the predictive battery of this study cluster themselves into three groups, as is clear from the hypothesis The three factors - (1) General Scholastic Temperament, (2) Personality (Non-intellective) and (3) Interest (curricular) are rather "arbitrary" It may be wondered if objective procedure is really necessary when the centroid solutions appear clear with the crude subjective analysis. These seem to be choice solutions only because there are clearcut clusterings of variables into three different groups

The orignal centroid solution is poor from a simple structure point of view Graphical procedures are useful to transform "arbitrary" factor matrices into "meaningful" factor matrices satisfying the simple-structure principles. The intuitive - graphical solution is attempted for the first pair as a check only (Please refer to Table No 3 9-4)

Scientific or analytical methods do not depend on subjective operations Ferguson designed a process of assigning to a vague and perhaps largely intuitive concept a precise, explicit and formal meaning. He suggested an objective analytical solution He proposed that some function of the sum of products of coordinates of a set of collinear points may be used as a measure of the amount of parsimony associated with the description of these points. Parsimony being one of the fundamental standards in selecting a preferred solution out of the infinite possible solutions, is the basis of simple-structure principles. Therefore, the "arbitrary" factor matrix can be transformed into "meaningful" factor matrix by such an analytical rotational method satisfying the simple-structure principles.

Carroll applied analytical methods and developed the first truly analytical rotation criterion or determining psychologically interpretable factors Kaiser's "Varimax" method for transforming the initial centroid solution to a simple structure solution is adopted in this research High-speed electronic computers made the application of laborious computations beyond two or three factors feasible since 1958 in the West For want of such facilities in India these computations had to be done by either hand or desk calculators. Therefore, the factor-loadings had to be recorded to two decimal places only.

The "Varimax" Solution :

The "Varimax" solution oppears to be the best parsimonious analytical solution. Arbitrary decisions are still required to determine "significant" factor loadings, "large" or "near zero" factor loadings, "sub-groups" of variables etc

As Prof. Harman* has pointed out more emphasis is placed on the simplification of the columns or factors of the factor matrix in an attempt to meet the requirements for simple structure in this method When the variance of a factor is at a maximum the factor has the greatest simplicity or interpretability in the sense that its components tend towards unity and zero.

In this method factors are rotated two at a time and the complete cycle of $\frac{m(m-1)}{2}$ pairings of factors is repeated In this study four factors are reported by the Centroid method Thus there are six pairs of factors to be rotated and the number of rotations becomes six In order to obtain the rotated factor loadings the angle of rotation ($\emptyset$) for each of the six rotation in the plane of the initial factors is worked out Squares and cross-products of the initial factor loadings are calculated

Approximate worksheets for all the data that have to be computed and recorded in the process of carrying out the analytical rotation of initial factors, pairwise, are prepared In calculating the tangents the numerators and denominators are determined separately so that the algebraic signs are noted

---

* Modern Factor Analysis, Harman, 1964

TABLE No. 3 9-3

(From Table 3 8)

INITIAL FACTOR MATRIX

Variables	I_0	II_0	III_0	IV_0	Communality
N	4763	- 1856	-.1316	- 2224	3290
IR	.4527	-.2991	- 2609	- 2378	.4190
V	.5013	- 3846	-.3392	-.1545	5382
Sc. Int.	.4577	- 2591	- 4394	- 1044	4806
B1N	6454	6676	- 0006	- 0601	8658
F1C	.6002	.6977	0019	-.0739	8525
DR	.3251	- 1827	- 2879	3313	3317
Hu Int.	-.2818	- 1096	5729	- 0825	4264

Before switching on to the Varimax solution the rotation of Factors I_0 and II_0 was attempted by the graphical method as a sort of check for computations of the Varimax solution The angle of rotation worked out subjectively on graph paper happened to be - 36°.

The initial and rotated factor loadings for the two factors are .-

TABLE No 3 9-4

INITIAL AND ROTATED FACTOR LOADINGS

(First two factors only)

(Angle of rotation is-36')

Variables	I_0	II_0	I	II_r
N	.4763	-.1896	.4944	.1298
IR	.4527	- 2991	.5420	.0241
V	.5013	- 3846	6316	- 0165
Sc. Int.	4577	-.2591	5225	0594
B1N	.6454	.6677	1297	.9194
F1C	.6002	.6977	0754	.9172
DR	.3251	-.1827	3704	.0433
Hu Int.	- 2818	-.1096	- 1635	2543

For want of electronic computer facilities many computations had to be done by hand only. There fore, when all the six rotations were attempted pairwise for the Varimax solution the factor loadings of the intial four factors were reduced to two decimal places only.

(1) First rotation $I_0 \quad II_0 \rightarrow I_1 \quad II_1$

The angle of rotation worked out by the analytical method tan 4 $\varnothing$ = 7266 (both numerator and denominator are negative)

$$\therefore 4\varnothing = -104^\circ$$
$$= -36^\circ$$

came to be-36° again as that by the graphical method. Therefore the rotated factor loadings were the same as given in Table No 3 9-4.

(2) Second rotation $I_1 \quad III_0 \rightarrow I_2 \quad III_1$

(tan 4 $\varnothing$ = 2 7373, 4 $\varnothing$ = -110° 4' $\varnothing$ = -27°.31')

The angle of rotation came to be - 27° 31'

(3) Third rotation $I_2 \quad IV_0 \rightarrow I_3 \quad IV$

(tan 4 $\varnothing$ = 2 0871, 4 $\varnothing$ = - 115° .36' , $\varnothing$ = 28° .54')

The angle of rotation $\varnothing = -28_0\ 54'$

(4) Fourth rotation $II_1 \quad III_1 \rightarrow II_2 \quad III_2$

(tan 4 $\varnothing$ = - 0428 ,4 $\varnothing$ = -2° 27' , $\varnothing$ = - 37')

$$\varnothing = -57^\circ 37'$$

(5) Fifth rotation $II_2 \quad IV_1 \rightarrow II_3 \quad VI_2$

(tan 4 $\varnothing$ = - 0797, 4 $\varnothing$ = - 4° 33' , $\varnothing$ = - 1°.8)

$$\phi = 9_0 .8'$$

(6) Sixth rotation $III_2 \quad IV_2 \rightarrow III_1 \quad IV_3$

(tan 4 ϕ = - .2059, 4 ϕ = - 11° 38' , ϕ = 2° .54')

$$\phi = -2^0 .54,$$

TABLE No 3 9-5

RESULTING ROTATED LOADINGS

Variables	I_3	II_3	III_3	IV_3	Communality
N	.54	.13	11	04	32
IR	.54	02	.01	.07	42
V	.56	-.02	-.03	48	.54
Sc. Int	27	05	63	.06	47
B1N	12	92	07	01	86
F1C	.09	.92	04	- 02	85
DR	.25	.04	01	.51	.33
Hu. Int	-.31	-.25	44	- 23	41

The Four Rotated Factors - (Varimax Solution)

The rotated factors are certainly clearer and more meaningful than the initial centroid factors.

The First underlying factor (I_3) has positive loadings in respect of cognitive ability variables (N, V, IR and DR), Science Interest variable and also Personality variables, though the loadings of Personality variables are very small. Humanities Interest variable has negative loading on this factor.

It can be confidently said that the first rotated foctor is *General Scholastic Ability*. Pursuit of a course of study in science demands better General Scholastic Ability and the factor loading of this variable justifies the above contention The-ve loading of Humanities Interest variable on this factor signifies that students offering Humanities course of study and scoring more in Humanities interest possess lesser General Scholastic Ability than required for prosecuting a course of study at the secondary stage

When the selection of students for Science and Humanities courses and these two courses cater to the need of more than 80% students at the secondary stage, is done on the basis of achievement in VIII class, more promising students with better General Scholastic Ability are admitted into the Science stream Only a few (5%) are admitted into Commerce, Technical and Agriculture courses The rest have to come to Humanities stream which eventually serves as a lumber centre because there is no provision of other occupational courses where such students with below average General Scholastic Ability can fit in

On the initial or centroid 'First' factor-General Scholastic Temperament - personality variables had the highest loadings while on the rotated 'First' factor congnitive abilities have the highest loadings. Therefore, this general power factor (I_3) appears to be an ability factor and not the temperamental factor.

The Second Factor (II_3)

The second rotated factor is Personality (non-intellective) factor as is the case in the initial solution All the other variables excepting Humanities Interest which has negative loading on it and Personality variables which have maximum positive loadings on them have "neer zero" loadings on this factor

In the initial Centroid Solution this factor Personality (non - intellective) - was contrasted with Cognitive abilities and Interest. In the rotated solution the loadings of the Personality variables had increased considerably and these variables are contrasted with Humanities Interest variable only.

This suggests again that those offering Humanities course of study appear to be less confident and emotionally more unstable of their scholastic pursuit in that stream It supports the earlier argument in case of the first rotated factor about students offering Humanities course of study

The Third Factor (III_3)

On this factor loadings of Science and Humanities interest variables are "large" Loadings of other variables (Cognitive abilities and Personality) are "near zero" This indicates that it is "Interest" factor as is the case in the initial solution The 'Interest' variables are contrasted with Cognitive ability variables in the initial solution

After prosecuting a course of study interest in that cours is gradually acquired by students which influences their achievement in examination This acquired interest is neither a temperamental quality nor an intellective ability. This is clear from the "near zero" loadings of these variables on this factor

From the percentile norms (Humanities and Science Interest) a supporting conclusion to the above contention can be drawn Science Students have acquired more interest in Science (P50 is 50) than that in Humanities (P 50 is 32) and the Humanities students have acquired more interest in Humanities course of study (P50 is 40) than that in Science (P 50 is 36)

The Fourth factor (IV_3)

While in the initial solution the fourth factor is not clear and therefore cannot be named it is clearer in the Varimax solution. The 'large' loadings of verbal Ability and Deductive Reasoning Ability which is saturated with vocabulary and Word fluency suggest that this factor can be named as "Verbal" or Linguistic" ability factor.

Only Humanities Interest variable has a negative loading on this factor while other variables (Personality, Numerical and Inductive Reasoning abilities and Science Interest) have 'near zero' loadings on it

Students offering Humanities course of study appear to possess less linguistic ability This shows that this group offering Humanities for want of other occupational courses at the secondary stage includes some students who lack in linguistic expression and they may benefit more by offering occupational courses rather than the Humanities course.

TABLE No 3 9-6

ROTATED FACTORS AND THEIR VARIANCES

	Factors			
Variables	I$_s$	II$_s$	III$_s$	IV$_s$
N	29 16%	2.00%	1.00%	0
IR	40 96 ,,	0 ,,	0 ,,	0
V	31.36 ,,	0 ,,	0 ,,	23%
Sc. Int.	7 29 ,,	0 ,,	39 69 ,,	0
B1N	1 00 ,,	84 00 ,,	0 ,,	0
F1C	0 ,,	84 00 ,,	0 ,,	0
DR	6.25 ,,	0 ,,	0 ,,	55%
Hu Int.	-9.00 ,,	-6-25 ,,	19 36 ,,	-5%
Percentage variance	29%	43 5%	16 00%	11 5%
	General Scholastic Ability	Personality (non-cognitive)	Interest (Curricular)	Linguistic Ability

Variances of the Rotated Factors :

The first rotated factor (General Scholastic Ability) contributes 29% of the total variance contributed by the factors to the battery This factor is weighted by cognitive abilities (N, V, IR and DR) and Science Interest; IR ability having the highest weight Humanities Interest contributes negatively while the contribution of Personality traits is nil.

The second rotated (*Personality* - non-intellective) is contributing 43.5% of the variance Kelley and May had reported that 40% and 42% weights respectively should be given to Personality as a contributor to Scholastic success

The third factor (*Curricular Interest*) weighs 16% in its contribution to the battery. Besides being a determiner of a specific course of study 'Interest' appears to justify its place in the team of predictors for scholastic achievement.

The fourth factor (*Linguistic Ability*)) subscribes 11.5% of the total variance It expresses that acquisition and expression of the acquired knowledge at the secondary stage is related to linguistic Ability

Norms :

A raw score does not convey any usable information Therefore, test scores are freqnently reported in terms of centile norms They give us an idea of the general level of a score in a known population and put scores from different tests on a comparable basis Centile norms are especially usefull when one desires to evaluate and compare scholastic achievement of a given student in different tests

Selected centile norms have been tabulated for the sample and sub-samples and are reported in Appendix A

REGRESSION AND PREDICTION 3

Regression :

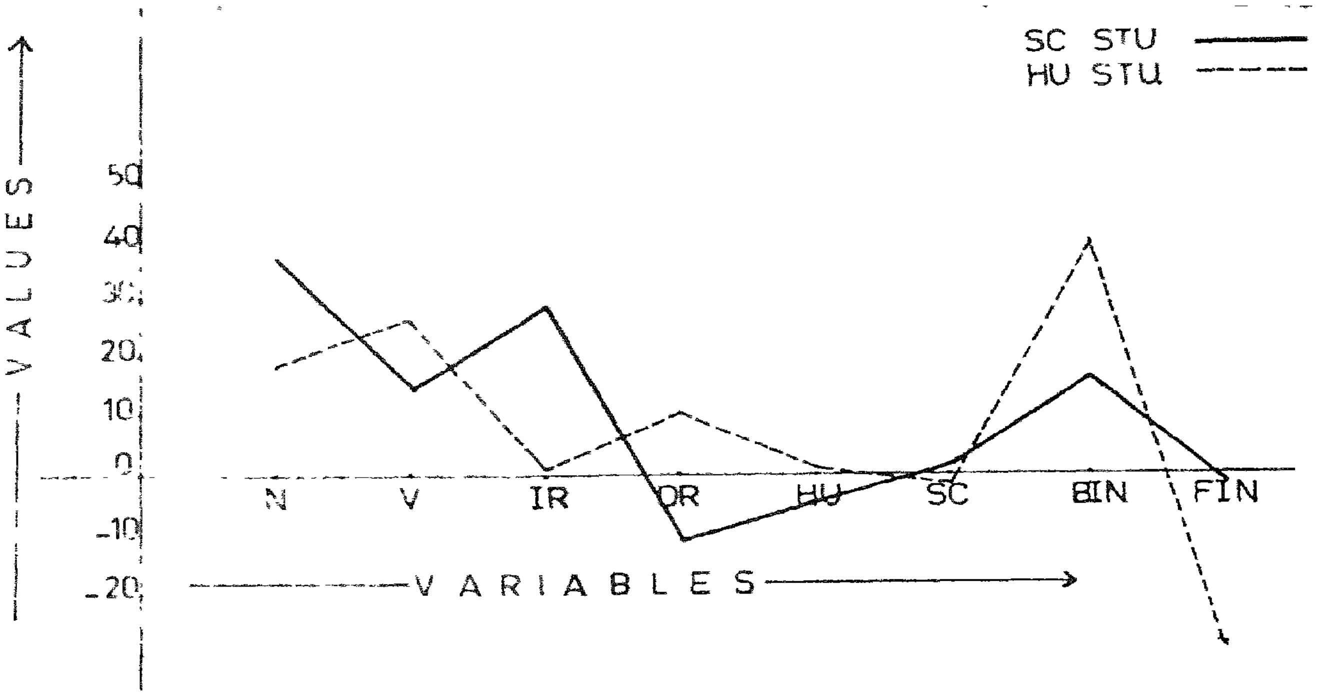
Regression helps us to predict the most likely measurement in one variable from the known measurements in the other The higher the correlation between two variables, the greater is the accuracy and the smaller the errors of prediction When several variables are related to the criterion it is possible to determine the relative best weights which are to be accorded to each in order to maximize their joint effectiveness. Hull has illustrated in detail multiple - correlation or regression line technique can be applied to combine scoreson several tests in order to obtain from them maximum prediction

The multiple-regression approach assumes that the regressions among the measures going into an equation are linear The actual and potential existence of many curvilinear regressions is pointed out in case of interest and temperament scores It is possible by transformation to reduce such regressions to rectilinear form, viz by the help of a cut-off score as proposed by Guilford

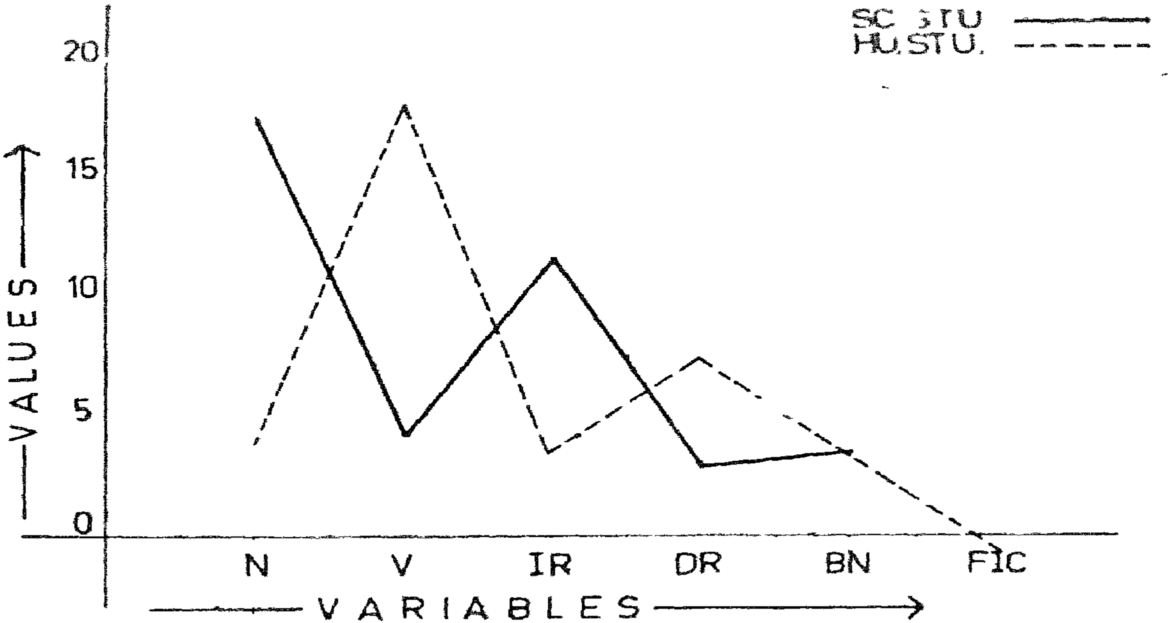
By a simple manipulation of formulae there is determined at the same time the correlation which is made by the battery as a whole when properly weighted will have with the criterion From this co-efficient an excellent index of the predictive power of the battery is secured

Regression Coefficients :

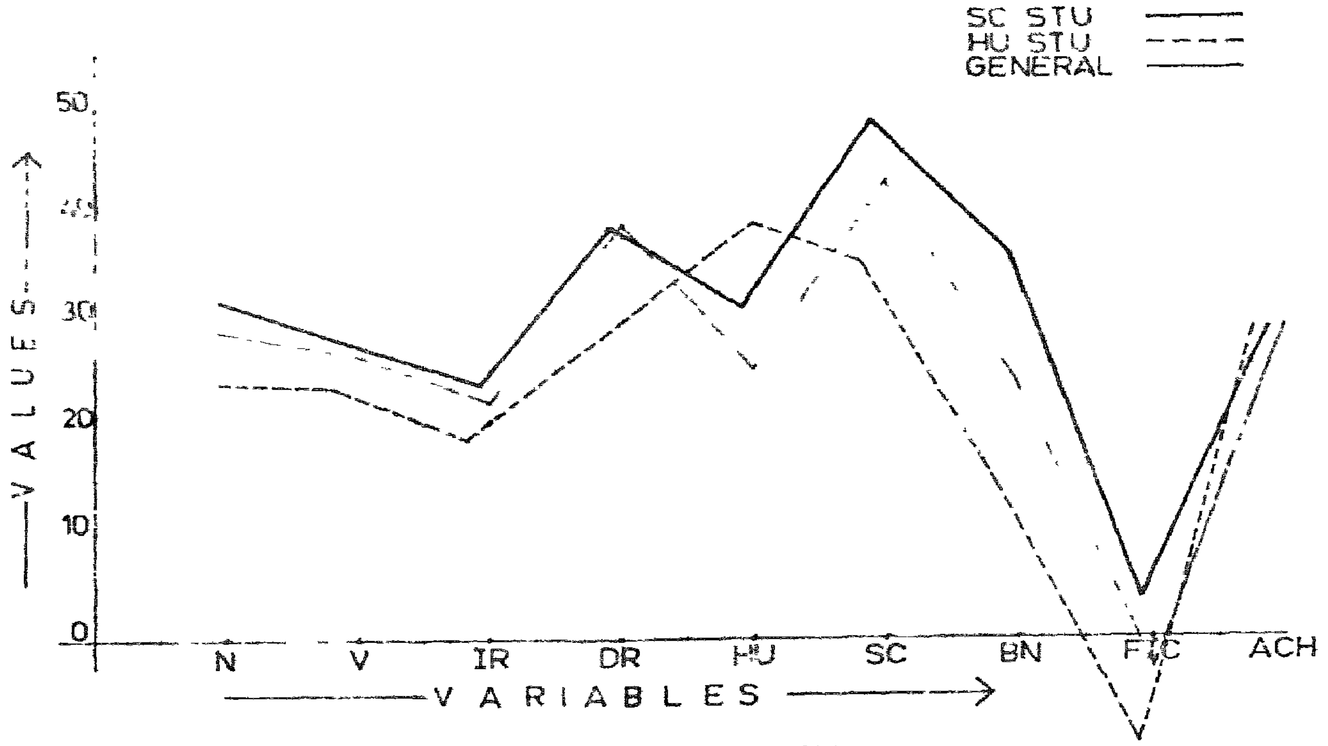
Regression coefficients using all the predictor variables are calculated for scholastic achievement by the inverse matrix method (Appendix B) By using this inverse regression weights for the variables in the battery are determined Gengerelli has reported a simpler merhod - the method of exhaustion - for calculating regression coefficients This procedure utilizes a process of successive extraction in obtained B s where each successive B is maximized and permits to discard those weights which are deemed unsatisfactory for purposes of prediction The R obtained by this method is smaller than that yielded by the inverse matrix technique.



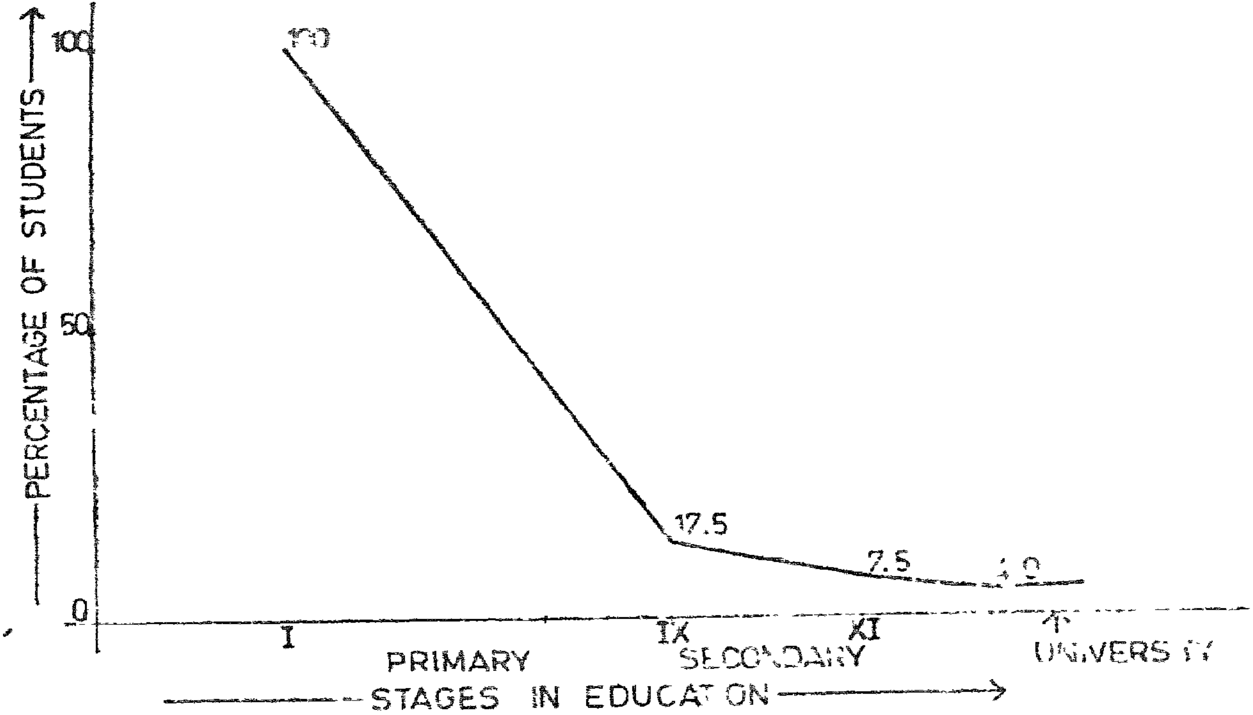
Regression Coefficients Profiles:



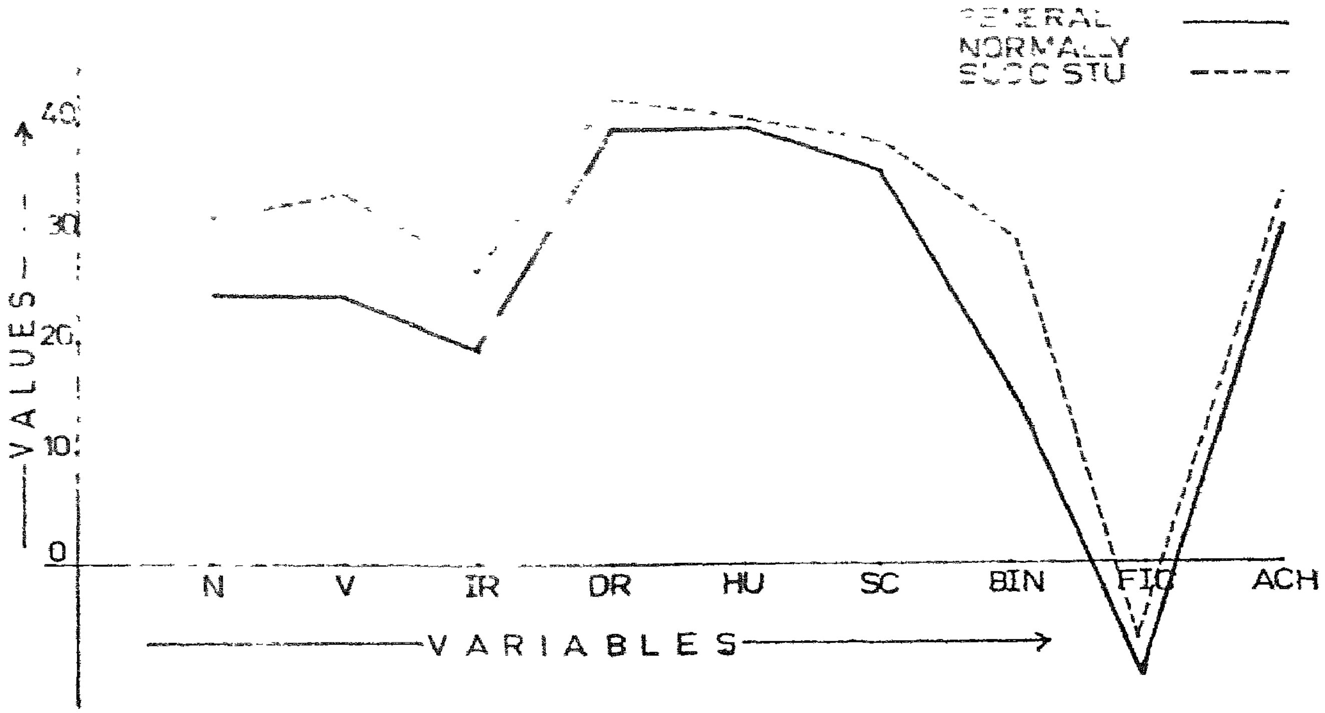
Percentage Variances of the Predictors:



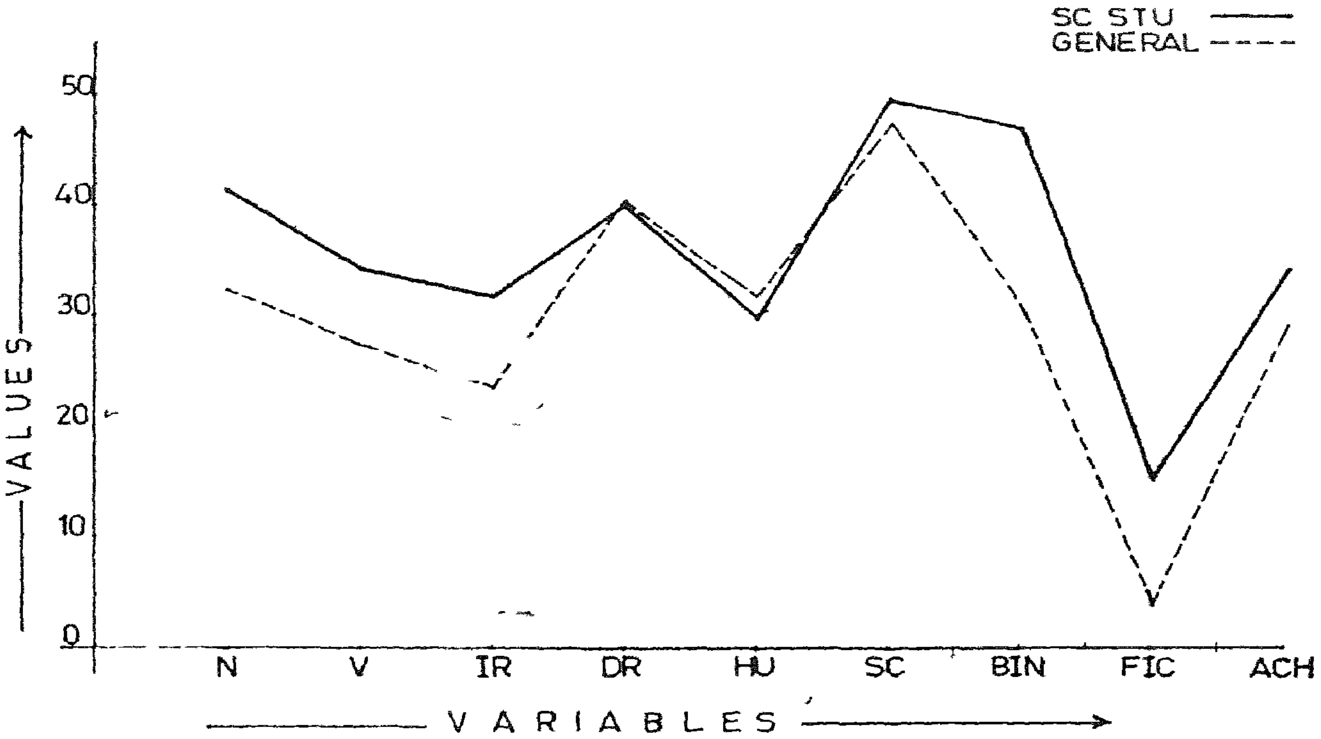
Predictors - Criterion Profiles:



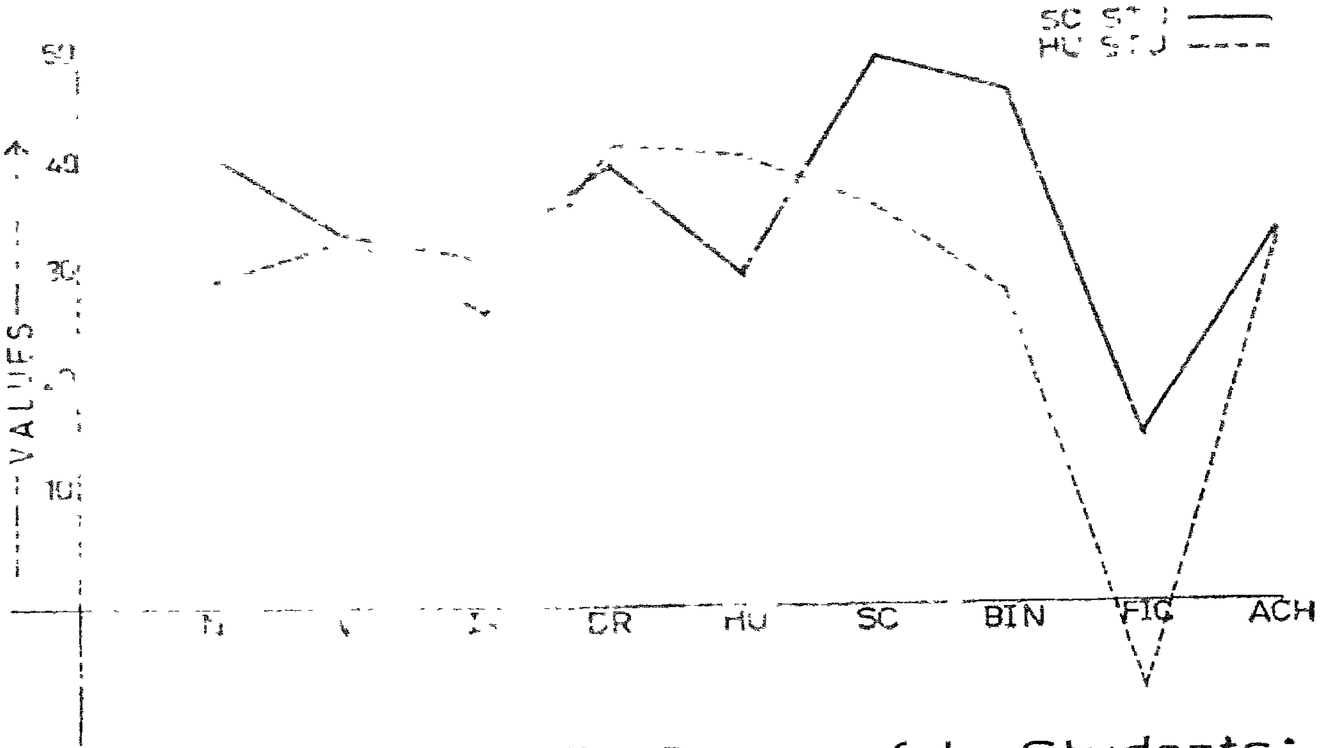
Wastage and Stagnation in Indian Education:



Humanities Students Profiles:



Science Students' Profiles:



Profiles of Normally Successful Students:

(Shortening of the predictive battery is not attempted in this study and has to be taken up as a follow-up so that the task of selecting students for secondary schools and prediction of their scholastic success could be made easier.)

The regression coefficients are :

TABLE No. 4.1

= 1

REGRESSION COEFFICIENT (M Method)

(in descending order)

Criterion	Variables							
	N	IR	B1N	V	Sc. Int.	F1C	Hu. Int	DR
Science Achievement	.3406	.2350	1705	.1312	.0020	-.0315	-.0403	-.1068
	B1N	V	N	DR	IR	Hu Int.	Sc. Int.	F1C
Humanities Achievement	.3852	.3062	1904	0986	.0943	.0321	-.0140	- 2743

The battery of eight variables of this study is intended to be used for the selection of students for Humanities and Science streams after their general education and predicting their scholastic achievements in those streams with the help of scores on the eight variables

The researcher is not only interested in the numerical values of the regression coefficients of the eight variables but in their signs (directions) also Knowing full well that the criterion available (school marks in different subjects) is fallible he hopes that the numerical values could be more with a better criterion (scholastic achievement) Till then he has to work with such results The new concept of evaluation which eventually would provide a better criterion is engaging the attention of teachers.

The regression coefficients of the predictor variables for science when arranged in the descending order (Table No 4 1) show that 'Numerical Ability' has the highest coefficient. The orders of variables are worth attention.

Science N IR B1N V Sc Int. F1C Hu Int. DR

Achievement ——— + ve ——— ——o——— -ve ———

Humanities B1N V N DR IR Hu. Int. Sc. Int. F1C

Achievement ——————— + ve ——————— o ——— -ve ———

N, IR, B1N, and V have + ve regression co-officients in respect of science achievement in that order, while F1C, Hu Int, and DR have — ve coefficients

In the case of Humanities achievement B1N is at the + ve and while F1C at the — ve end. Only Sciense Interest Variable has – ve coefficient besides F1C in respect of Humanities achievement

In both the achievements F1C - confidence in oneself has ve coefficients Secondary School Students in our country are losing faith in their studies because education at this stage of life is not able to solve their basic problem i e earning a living This crisis of confidence has resulted in mass unrest in students Mass copying and indiscipline in centres of examination are very common now-a days The -ve coefficient of F1C in respect of both the streams is a pointer to this trend

Science interest has a + ve coefficient (though too small) and Humanities interest a - ve one on science achievement While in respect of Humanities achievement Humanities interest has a + ve coefficient and Science interest a - ve one The directions (signs) of coefficients of both the Interest variables (Science and Humanities) on the respective criteria are in the expected direction.

When several score weights are summed in a regression equation it weighs them in proportion to their standard deviations Like other statistics the regression coefficients have their sampling errors The SE of a regression co efficient is given by the formula

$$SE = \frac{b\ Co}{b\ Va} \quad \frac{1 \quad r^2}{N}$$

The value of SE tells us whether a variable is contributing anything to the prediction of the criterion by way of the multiple regression equation If B is not significant, i e. when regression coefficient is not significantly greater than zero, the term containing the regression coefficient - and the variable - can safely be dropped from the regression equation

TABLE No. 4 2
REGRESSION COEFFICIENTS AND THEIR RELIABILITIES (RAW SCORES)

	Variables							
Groups	N	V	IR	DR	Hu Int	Sc Int.	B1N	F1C
Sc St B	.3406	.1312	.2350	- 1068	-.0404	.0020	.1705	- 0315
N-344 6B	.0336	.0398	0381	0597	.0269	0306	0063	006
Sig.	Sig	Sig	Sig.	Non-Sig	Non-Sig	Non-Sig	Sig	Sig
Hu St B	.1904	3062	0943	0986	.0321	-.0140	.3852	- 274
N 296 6B	0307	.0322	.0303	0546	0252	.0256	0054	004
Sig	Sig.	Sig	Sig	Non-Sig.	Non-Sig	Non-Sig	Sig	Sig

In this study, regression coefficients of DR, Hu Int and Sc Int because of their significant errors for both the groups deviate from the population coefficients DR is retained presently, because it has highest positive loading for the fourth rotated factor As pointed out earlier (Ch I) 'Interest' test is useful, mainly as a determiner of a course of study to be offerred than as a contributor to the prediction of scholastic success as a component of the team of predictors Hence, the 'Interest' tests are retained. Guilford has suggested that a successive selection of tests by a method such as the Wherry-Doolittle is unnecessary when all the factors that are worth predicting are taken care of by the tests even if they number more than five

Multiple Regression Equations :

The multiple regression equation which is a means of combining different measures of the same object in order to derive a composite measure or score is used for determination of the importance or weight of each of a number of variables. It is more convenient to estimate a student's score in the criterion directly, from the scores in the predictor variables. This is done by using the score form of the regression equation.

$$
\begin{array}{rlcl}
C = & W1 & X & N \\
+ & W2 & X & V \\
+ & W3 & X & IR \\
+ & W4 & X & DR \\
+ & W5 & X & Hu.\ Int \\
+ & W6 & X & Sc.\ Int \\
+ & W7 & X & B1N \\
+ & W8 & X & F1C
\end{array}
$$

The regression coefficients give the weights to be attached to the scores in each of the predictor variables when a criterion measure is to be estimated from all these in combination Such a weight (W) which a variable exerts individually in determining the criterion excludes the influence of the other variables. The role each of the eight predictor variables plays in determining the criterion measure is evident from the regression equation.

The multiple regression equations in terms of scaled raw sub-criteria, Science Achievement and Humanities Achievement are

$$
\begin{aligned}
\bar{\bar{Y}}\ Sc. = {} & .37xN + .28xIR + .16xV + .03x\ B1N - \\
& .01xF1C - .03x\ Hu\ Int. - 22x\ DR + 23\ 46
\end{aligned}
$$

$$
\begin{aligned}
\bar{\bar{Y}}\ Hu = {} & 36xV + 20xN + 19xDR + 10x\ IR + 07xB1N + \\
& 03xHu\ Int. - 01xSc.Int - .05x\ F1C + 18\ 17
\end{aligned}
$$

The weights in the regression equation as above are the nominal weights or the multiplicative factors for the linear combination of predictor variables.

The composite variances :

It is possible to estimate proportion of the total variance contributed to the composite by each variable as proposed by Richardson as follows :

$$
\begin{aligned}
6^2 r = {} & W1\ (W1 + W2\ r12 + W3\ r\ 13\ \ldots\ldots\ Wn\ r1n) \\
& + W2\ (W1\ r\ 12 + W2 + W3\ r\ 23\ \ldots\ldots\ Wn\ r2n) \\
& + Wn\ (W1\ r1n + W2\ r2n + W3\ r3n.. + Wn\quad)
\end{aligned}
$$

Percentage variance of the composite for the two sub-criteria are calculated and reported below :

$$
\begin{aligned}
6^2\ Sc = 36\ 705\% = {} & 17\ 49\%\ (N) + 11.68\%\ (IR) + \\
& 4.54\%\ (V) + 2.715\%\ (DR) + 28\%\ (B1N)
\end{aligned}
$$

6^2 Hu. = 36.16% = 18.50% (V) + 7.74% (DR) +
6 95% (N) + 3.47% (IR) — 5% (F1C) . .

The proportion of the percentage variance of a variable contributed to the total variance of the composite is calculated from the above

The respective values are :

Science Achievement			Humanities Achievement		
N	=	47.65%	V	=	51 16%
IR	=	31.82%	DR	=	21.40%
V	=	12.37%	N	=	19 22%
DR	=	7.40%	IR	=	9 60%
B1N	=	.76%	F1C	=	-1.38%
		100%			100%

It is quite clear from the proportions of the percentage - variances contributed by the variables to the composite that the differential aptitude tests (N, V, IR and DR) cluster into two distinct groups to determine the two sub-criteria - Science achievement and Humanities achievement - in the two diversified courses of study Both personality and interest which measure non-cognitive aspects of the mind appear to contribute needs no explanation simply because the criterion at hand - school marks of essay-type examinations - tests cognitive aspecets of the mind and therein memory above all.

The variance contributed by School examinations - essay-type examinations mostly - to subsequent scholastic achievement for prediction purposes ranges between 25 to 30 percent The percentage variances of the variables of the predictive battery of this study for the two sub-criteria are 37% (Sc.) and 36% (Hu.) respectively. The battery serves the twin purposes of selection of students for the two streams and prediction of subsequent achievement. The higher values of the percentage variances of variables obtained justify the utility of the battery for selection of students and prediction of their achievement.

Multiple R :

A coefficient of multiple correlation gives us the correlation between a set of obtained measures and the measures predicted from the multiple regression equation. Expressed in the light of this investigation R gives the correlation between the measures of the sub-criteria - Science Achievement and Humanities Achievement - and those obtained from the predictive battery should certainly be not sacrificed when the criterion school marks of essay-type examinations in this study - is imperfect Therefore, even though the optimal or effective weights to be assigned to the predictor variables are calculated no attempt is made to select and retain those tests that possess best weights only

The values of R, SE of R, significances of R by variance ratio method and weighted R of the predictive battery are given below

Criterion	R	σR	Corrected	Weighted
Science Achievement	573	0367	56	606
Humanities Achievement	525	0426	508	.601

The standard error of a multiple R is given by the formula

$$SER = \frac{1 - R^2}{\sqrt{N - M}}$$

The values of R for Science Achievement and Humanities Achievement 573 and 525 being not spectacular their standard errors are calculated

Significances of Rs were tested by the variance ratio method (Johnson) also, by the formula

$$F = \frac{R^2 (N - m - 1)}{m (1 - R^2)}$$

The obtained Rs are corrected to give better measures of the population R s by the shrinkage formula

$$R_c^2 = 1 - R^2 \frac{(N - 1)}{(N - m)}$$

These values are 56 for Science and 508 for Humanities

Prediction :

A more efficient utilization of our manpower resources depends very largely on the improvement of techniques for predicting scholastic success of students in each of the diversified courses offered at the secondary stage Paul Horst and his associates say that the study of prediction of scholastic achievement affords an excellent opportunity for the development of scientific method in the psychological and social sciences. Prediction assists academic advisers in making their advice more effective by eliminating guess work in picking courses of study for students The predictive data helps administrators to guide changes in policy, student selection and admission Moreover, it improves guidance by matching up successes with mistakes identifying the causes of both success and failure and working towards the elimination of the cause of error

Prediction of Scholastic Achievement :

The problems we are confronted with are those of selecting membership of a student in a diversified course suited to him and of predicting his success in the course offered by him The solution of these problems offers us the probability of a student's success in the designated category of a course of study For this, we study the extent to which the battery leads to the prediction of scholastic achievement in either Science or Humanities from the scores of students on the tests of the predictive battery.

The predictive bettery of this investigation is designed to offer a single classification battery of eight variables which, by means of different measures on the eight variables enables us to predict scholastic achievement of students in either of the two major streams when they begin their secondary schooling Assignment of students to the two courses of study requires a differential prediction rather than a prediction on a single variable We have to predict how much better a student will perform if assigned to one category than if assigned to the other category. It is, therefore, attempted to predict the two different criterion measures from the same measures on the eight predictor variables of a student intending to offer one of the two courses.

The Predictive battery and the two sub-criteria :

Under ordinary conditions a battery of tests having an R which is an indicator of the predictive power of the battery, below 40 with a true criterion (correction being admitted) is hardly useful The practical range of R s for modern psychological tests occupies the narrow zone roughly between 40.

to 65. The post-war researches by Peel and Rutter and Emmett and Wilmut gave R s approximately, 60 between a battery of three tests - Intelligence, English and Arithmetic and equally weighted combinations of School Certificate subjects. The values of R (corrected) in this study being 56 (Science Achievement) and 508 (Humanities Achievement) prove the utility of the predictive battery of eight variables in predicting scholastic achievements of students offering the two streams - Science and Humanities

The importance of the predictor variables in determining the two criteria - Science achievement and Humanities achievement - is revealing also The eight tests group themselves into two operationally different camps in accordance with the diversity of the two courses of study.

TABLE No 4.3
PREDICTOR VARIABLES AND THE TWO STREAMS
(in descending order of importance)

Criterion	Variables	
Science	N, IR, B1N, V, Sc. Int	F1C, DR, Hu. Int
Achievement	(All positive)	(All negative)
Humanities	B1N, T, N, DR, IR, Hu Int.	FIC, Sc Int.
Achievement	(All positive)	(All negative)

The alignment of regression weights for the two streams is orderly and is in the expected direction B1N (Neurotic Tendency), V, DR and Humanities Interest discriminate in favour of Humanities, while N, IR and Science Interest together direct towards Science. The weights show true relationships among the predictors and the criteria The scores from which predictions are made are scaled raw scores on eight tests of the predictive battery

Predictive Validity :

After bringing them to a common scale the raw scores of the students (640) on the eight variables of the battery are substituted in the two multiple regression equations reported earlier This operation yielded predicted composite scores for Science and Humanities students, separately. The simple correlation between the obtained achievement measure on the criterion gives us the predictive validity of the battery

The correlations between these composite scores on the eight variables and the obtained achievement scores on the criterion are calculated separately for Science and Humanities students These r s are the validity coefficients of the battery against the two criteria which in this study are marks obtained by students in written essay type examination.

TABLE No 4.4

PREDICTIVE VALIDITY OF THE BATTERY

	Predicted Achievement		obtained Achievement	
	Science	Humanities	Science	Humanities
M	38.16	43 52	28 48	29 45
6	5 9	5 38	6 49	5 1

Science : Predicted & Obtained
Achievement Achievement r= 54

Humanities : Predicted & Obtained
Achievement Achievement r = 42

The co-efficients of predictive validity (54 for Science and .42 for Humanities) for the general groups are satisfactory but not spectacular. The fallible criterion (school marks of essay-type examinations) and the heterogeneous grouping of students into the two streams - Science and Humanities - are potent factors working against better predictive validity co-efficients for the battery.

The cut-off points for the normally successful students :

After a recent survey of wastage and stagnation in Indian education the Directorate of Man-power, Government of India has reported that from 100 children admitted into Class I (Primary) only 17-18 out of them, i e. 17 to 18% reach the secondary stage and seek admission in class IX, and only 4 pass the School Leaving Certificate Examination successfully and complete secondary education.

TABLE No 4 5

WASTAGE AND STAGANATION IN SECONDARY EDUCATION

Admitted		Pass	Percentage	
			Pass	Fail & Drop-out
17	Class IX	12	70 %	30 %
12	Class X	7, 8	65 %	35 %
7 - 8	Class XI	4	50 %	50 %

While only 24% students come out of secondary stage the total percentage of failures and drop-outs is 76

It is evident from the above statistics of the Government of India that out of the students coming to class IX for secondary education only 24% complete it successfully. This 24% is the normally successful class of students in secondary education

In view of the high percentages of failures in our examinations both at secondary and University stages resulting into stagnation and national waste we have to attempt to make the best classification of students when they select courses at the secondary stage. The rush of students to Science and Humanities is more harmful because other courses starve for talented students This imbalance is catastrophic Therefore it is intended to apply cut-off scores to the composite scores on the eight predictors and to select only those students who show better scholastic promises for the two courses of study, i e are the normally successful students Guilford has suggested that a cut-off point should be applied to the composite score so as to make the best classification of students with the smallest probability of error of classification McClelland in his classic investigation on secondary school selection has proposed a cut-off score — Mean + .66 6 - for students to be admitted into Grammar Schools. Students from Humanities and Science courses with higher predicted composite scores than the cut-off score which is 42 for Science and 48 for Humanities (as done by McClelland) are selected for further treatment

TABLE No. 4 6

PERCENTAGES OF THE NORMALLY SUCCESSFUL GROUPS OF STUDENTS IN THIS RESEARCH

Students	No above cut - off scores	Percentages		
		Total	Boys	Girls
Science 344	90	26 %	66 %	34 %
Humanities 296	65	22 %	35 %	65 %

The percentages reveal that girls excel boys in Humanities while boys are superior to girls in Science. Secondly, if only 26 % of students admitted into Science and 22 % of students sent to Humanities had been selected for the respective course prior to their admission stagnation and wastage could have been avoided Moreover, we would not have deprived other courses - Agriculture, Technical, Commerce, Home Science and Fine Arts - of students with abilities to profit by them.

The measures of Central tendency and dispersion of the normally successful students offering Science and Humanities courses are informative.

TABLE No. 4 7

THE NORMALLY SUCCESSFUL GROUPS OF STUDENTS

	Science students (90)		Humanities students (65)	
Tests	M	6	M	6
N	40.7780	7.1610	31.0769	8 6325
V	33 9444	7.3665	33.0000	7 5550
IR	31 5556	5.2515	26 2309	7 7520
DR	39 4333	5 3019	42 4154	3 3231
Hu. Int.	30 2078	12 1385	41 4444	11 6315
Sc. Int	50.0667	11 2000	36 0615	13.8103
B1N	-47 4444	55 3375	-28 3844	54,8925
F1C	-14 9444	56 0050	6 6156	52.6025
Ach	32 9010	5.7699	31.9886	5 4795

Normally successful science students possess less DR ability and Humanities Interest than those of the general (Science) group and the normally successful Humanities students. The 6 which indicates homogeneity if it decreases, of above group for Interest is less than that for the general (Science) group. This proves that the general sample of science students includes some students with more scholastic promise for Humanities and they would have benefitted more, had they offered Humanities or other courses instead of Science. The normally successful Humanities students show more Science Interest than that of the general (Humanities) group This reveals that some students with more scholastic ability and better scholastic promise for science are admitted into Humanities instead of Science. It is supported by the greater value of 6 of selected group (Humanities) indicating greater heterogeneity of the selected students than that of the general (Humanities) students. This demands a stricter classification to reject students with less promise for a course of study.

Normally successful students, both Humanities and Science, possess higher scores than the general groups on all tests including scholastic achievement. This is in the expeeted direction

Discriminant Function :

The students have been admitted to Humanities and Science courses arbitrarily. Proper classification of students for the courses of study is a must.

Under the conditions prevailing in our secondary schools it is very difficult to work out a 'Discriminant Function' Being fully confident of its utility and urgency for proper classification of students to diversified courses in class IX at the secondary stage the author has taken pains to calculate it from the scores of the students on the eight predictor variables of the battery

Every student whether offering Science or Humanities course of study is giving eight scores on the variables, Science students possess scores in Humanities Interest and Humanities students have scores in Science Interest besides their scores on seven other variables. Before assigning a student to either Science or Humanities course of study in Class IX his scores on the eight predictor variables could be obtained at the beginning of IX class session If from these eight scores of a student on the eight predictor variables it could be advised to him as to what course of study (whether Humanities or Science) suits him and with what promise, his scholastic pursuit in proper direction will not only be helpful and purposeful to him but, also to the society.

The sample of students taken for this study was 640 (Science 344 and Humanities 296). It was in the fitness of things to determine the group of successful students first so that the multivariate mean point of the scores ont he eight predictor variables of this normally successful group could be utilised to workout the 'Discriminant Function'. When the percentage of failures and drop-outs from the general sample of students is nearly 76% in secondary education it was inappropriate to calculate the multivariate mean point of the scores on the eight variables of the general sample for general application.

Some selection of students representing the normally successful group of students was to be done from the general sample This was achieved on the lines suggested by McClelland by applying a cut-off-score as explained earlier. The percentages worked out for the normally successful students after applying the cut-off-scores to the composite of scores on all the eight predictor variables are :

Science students	26 %
Humanities students	22 %

These percentages of normally successful students in Science and Humanities streams closely agree to the findings of the survey conducted by the Union Government

Therefore, measures of central tendency (Ms) of the normally successful group of students from amongst the general sub-samples had to be worked out for further calculations regarding the 'Discriminant Function', (Please refer to Table No. 4.7)

In this study there are eight measurements each (on the eight predictor variables) for all students offering both Science and Humanities courses of study in class IX.

Measurements (8) → $X_1\ X_2\ X_3\ X_4, \ldots \ldots X_8$

The linear function of the measurements maximizing the ratio of the difference between the means of the two groups to the standard deviation within groups is given by -

$$\alpha = \Sigma_i \lambda_i x_i \quad (i = 1, \ldots\ldots 8 \text{ measurements})$$

The difference between means of measurements of the two groups is represented by d_i, i. e $d_1, d_2, d_3, \ldots\ldots d_8$. The sum of squares of products from the specific means within groups is denoted by S_{ij}, where $i, \ldots j = 1, \; 8$ measurements

For any linear function α of the measurements, the difference between the means of α in the two specific groups is given as -

$$D = \Sigma_i \lambda_i d_i \quad (i = 1, \; . \; 8)$$

while the varianee of α within groups is proportional to

$$S_\alpha = \Sigma_i \Sigma'_j \lambda_i \lambda_j S_{ij} \quad (i, j = 1 \; . \; 8)$$

The particular function which best discriminates the two groups will be one for which the ratio $\frac{D^2}{S_\alpha}$ is the greatest by variation of the coefficients, $\lambda_1 \ldots \lambda_8$ independently

The Coefficionts(λs) are proportional to the solution of the normal equations -

$$\left.\begin{aligned} S_{11}\lambda_1 + S_{12}\lambda_2 + \ldots S_{18}\lambda_8 &= d_1 \\ S_{81}\lambda_1 + S_{82}\lambda_2 + \ldots S_{88}\lambda_8 &= d_8 \end{aligned}\right\}$$

$$\text{Where } L_i = \sqrt{S_{ii}} \times \lambda_i \quad (i = 1 \qquad 8)$$

Dividing i^{th} equation by $\sqrt{S_{ii}}$, we have the following set of normal equations -

$$r_{11} L_1 + \ldots r_{18} L_8 = \frac{d_1}{\sqrt{S_{11}}}$$

$$r_{21} L_1 + \ldots r_{28} L_8 = \frac{d_2}{\sqrt{S_{22}}}$$

$$r_{81} L_1 + \ldots r_{88} L_8 = \frac{d_8}{\sqrt{S_{88}}}$$

It is presumed that the averages of test scores indicate a point in the multi diemensional space and the dispersion indicates a region of permissible variation about that point. The likelihood that a student will form a homogeneous member of successful students is determined by relating the point in the multi-dimensional space indicated by his test scores to the region of permissible variation about the multivariate mean point of the normally successful students

Fisher has developed 'discriminant function' to solve the problem of discriminating and classifying students The notable feature of this function which is a linear function of the test scores is that it distinguishes better than any other functions between the spedified courses The steps described by Johnson are followed to calculate the 'discriminant function from the scores of students on the eight predictor variables. For Ls, the normal equations were attempted by Fisher's method of auxillary statistics, in which unity is substituted for each of the $\frac{d_i}{\sqrt{S_{ii}}}$ in turn while the others are made equal to zero The method of substitution, though somewhat lengthy is followed

The values for d (the d s are in favour of Science group because all means excepting those for DR and Humanities interest of Science students are greater than those of Humanities students (Table No 4 7), λ s and Ls are given in the following table .

The λ a are very small decimals and for convenience each λ is divided by the lowest λ weight as proposed by Garrett The values of $\underline{\lambda}$ s calculated as stated are also given)

TABLE No. 4 8

THE $\underline{\lambda}$ WEIGHTS FOR THE NORMALLY SUCCESSFUL GROUPS

Variables	D	L	λ	$\underline{\lambda}$
N	9 7011	.2620	.000063	1 000
V	9444	8014	.000216	3 44
IR	5 3257	-.5789	-.000176	-2 79
DR	-2 9821	3308	000077	1.22
B1N	19 0600	6167	000133	2 11
FIC	21 5600	-.2349	-.000181	-2 87
Hu. Int.	-11.1666	-.9584	-.000252	-4 00
Sc. Int.	14 0052	-.3263	-.000066	-1.05

After solving the normal equations the values of α separately for two groups (Science and Humanities students) are obtained from Ls. The means of α for these two groups are given by .-

$$Z = \bar{\alpha}\ Sc. = \sum_i \lambda_i \bar{X}\ Sc._i \quad (i = 1, \ldots\ldots 8) = 1.15$$

$$Z = \bar{\alpha}\ Hu. = \sum_i \lambda_i \bar{X}\ Hu._i \quad (i = 1, \ldots\ldots 8) = -1.57$$

where $\bar{X}_i$ is the mean value of X_i, for a group

Finally, $\alpha\ \alpha 1 + \alpha 2 + \alpha 3 + \alpha 4 + \alpha 5 + \alpha 6 + \alpha 7 + \alpha 8$

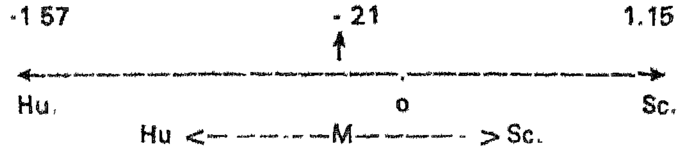
The critical point ($\bar{u}$) for the two groups - Science and Humanities - for the function a is -

$$\bar{u} = \frac{\alpha\ Sc + \alpha\ Hu}{2}$$

$$= \frac{1.15 - 1\ 57}{2}$$

$$= \frac{-\ 42}{2}$$

$$= -\ 21$$



A value of $\bar{u}$ for the linear function α can thus be obtained for a student from his scores on the eight tests of the predictive battery of this study directly. When this $\bar{u}$ value is more than - .21 (i. e above - 21) he should be admitted into the Science course and if less than - 21 a student should be admitted into Humanities course of study.

ANALYSIS OF VARIANCE OF 'BETWEEN' AND 'WITHIN' GROUPS

(Normally successful students)

Source of variation	D. F	S. S.	F	
Within groups	146	00016	...	Hypothesis
Between groups	8	.000001	11 248	rejected

Referring to the F-table with $n_1 = 8$ and $n_2 = 146$ we find $p < 01$ Therefore, we reject the hypothesis of homogeneous groups, and the relative value of the variable α for discriminating between the two groups - Science students and

Humanities students - is apparently indicated by the weights (λs) of the different eight measurements of students on the eight variables of the battery The obtained values of λ are thus the assigned weights of the eight measurements which best discriminate these two groups.

Decisions about assigning students to either of the two groups (Science and Humanities) in class IX are presently made on the basis of a single variable, i. e. the school marks of these students in Class VIII which itself is a fallible criterion As pointed out in this study more often, the two groups of students (Science and Humanities) differ in several variables each of which gives some indication as to the group in which the individual should be placed so that he would be able to complete that course of study and profit by it.

The values of eight $\underline{\lambda}$ s —

($\underline{\lambda}$ N = 1, $\underline{\lambda}$ V = 3.44, $\underline{\lambda}$ IR = 2.79, $\underline{\lambda}$ DR = 1.22,
$\underline{\lambda}$ B1N = 2.11, $\underline{\lambda}$ F1C = -2.87, $\underline{\lambda}$ Hu Int. = -4 and
$\underline{\lambda}$ Sc. Int = -1.05) — are calculated from the measurements of the normally successful students offering Science and Humanities courses on the eight variables (N, V, IR, DR, Hu Int., Sc Int., B1N and F1C) of the battery so that students with promise could be selected for the two courses of study-Science and Humanities, with the help of $\underline{\lambda}$ s later on.

From the values of $\underline{\lambda}$ s calculated earlier for the normally successful groups of Science and Humanities students the values of $\bar{\alpha}$ Sc and $\bar{\alpha}$ Hu. are calculated for the general groups also This was to see whether the values of $\underline{\lambda}$ s for the eight measurements of the normally successful students on the variables of the battery could be applied to the general samples also to discriminate them significantly from each other The author was conscious of the fact that the general groups included 76 percent failures and drop-outs at the initial stage, i e at the beginning of class IX, the stage where students are to be discriminated in favour of either Humanities or Science, and, therefore, they could not be taken as samples of normally successful students

The means of measurements of Science and Humanities students-general sample-on the eight variables of the battery are :

TABLE No 4 9
MEASURES OF CENTRAL TENDENCY FOR THE GENERAL GROUPS

Variables	N	V	IR	DR
Science	31.8690	28.0610	24.2240	39.4623
Humanities	24.3486	23.4360	19.1805	30.2028

Variables	Hu Int	Sc. Int	B1N	F1C
Science	30.8369	49.0698	-30.5870	3.6700
Humanities	24.3485	34.7604	-13.5740	9.8030

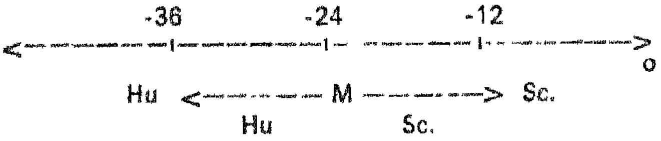
The required discriminant functions for average students representing both the groups - Science and Humanities - calculated separately from the above measures are .

$Z_{(\bar{\alpha}\ Sc)}$ = 31.8690 + 3.44 (28.0610) -2.79 (34.2240) + 1.22 (39.4623) + 2.11 (30.5870) -2.87 (3.67) -4(30.8369) - 05 (49.0698)

= -11.9063

$Z_{(\bar{\alpha}\ Hu)}$ = 24.3485 + 3.44 (23.4360) -2.79 (19.1805) + 1.22 (30.2028) + 2.11 (13.5740) -2.87 (9.8030) -4(58.9457) -1.05 (34.7604)

= -36.2233



Thus it is evident from the above that the discriminant function for an average student (we do not know whether he will be able to pass the final examination) offering science course of study is -12 and that for an average student offering Humanities is -36 After setting up the discriminant function it is found to give good differentiation of the students offering Science and Humanities courses of study in general though the range is in the -ve direction only in comparsion to that with the normally successful groups

In other words, knowledge of the scores on the eight variables of the battery of this study could be combined in a discriminant function to give a very good indication as to what course of study, Sc or Hu , a student should offer so that he could be normally successful in it i e belongs to the normally successful group of students

A test of the significance of the discriminant function by means of the analysis of variance for the general groups is made,

$D =$ Sum of squares within groups for $n_1 + n_2 - K - 1$
degrees of freedom = 631

The sum of squares between groups for k degrees of freedom, where k = number of variables in the battery

$$\text{is} \left\{ \frac{n_1 \times n_2}{n_1 + n_2} \right\} D^2$$

ANALYSIS OF VARIANCE OF 'BETWEEN'
AND 'WITHIN' GROUPS - (general samples)

Source of variance	D F	S S.	F	
Within groups	631	0015	18 75	Hypothesis
Between groups	8	,00036		rejected

Referring to the F table with $n_1 = 8$ and $n_2 = 631$ we find P *L* .01 Therefore, the hypothesis that both the groups - Science students and Humanities students in general - are homogeneous is rejected This suggests that the obtained values of α are the assigned weights of the eight measurements which best discriminate these two groups in general also

Whether a smaller number of variables than eight would give complete discrimination without the assistance of the remaining variables is not considered here The whole problem of preparing a shorter battery than the present battery of eight variables is left for follow up and is not intended in this research.

RETROSPECT AND PROSPECTS : 4

Interpriting Results :

All measures of central tendency and dispersion on predictor variables and the criterion of the sample (640) of IX Class students (Vidarbha) of 14 + offering Humanities and Science courses in Secondary Schools represent population parameters Therefore,the psychological measurements of the sample of this study can safely be generalized for the population i e students of Class IX of Secondary Schools

Correlation coefficients excepting that between Inductive Reasoning and Humanities Interest of the samples are very significant The correlation between Verbal ability and Humanities Interest is significant at 5 % level of confidence This means that all 'r's excepting that between IR and Hu Int represent population rs IR ability is a good measure of general scholastic ability Science students as a group are better in IR ability, i e they possess better promise for scholastic pursuits The DM on IR ability is very significantly in favour of Science students The DM on Humanities interest is very significantly in favour of Humanities students. It can, therefore, be safely deduced that students who have offered Humanities as a group and those students in the Science group who possess a higher degree of interest in Humanities course have lesser scholastic or intellective ability. This finding is very significant, in that it suggests that these students would have either profitted themselves more by offering professional courses in Secondary Education - Agriculture, Commerce, Fine Arts, Home Science, etc - instead of offering academic courses - Science and Humanities or that they should have preferred vocational courses as Teaching, Nursing, Industrial management, etc.

The directions of the differences between sub - groups (Humanities and Science) and the sample means suggest that there are marked differences in abilities and traits possessed by pupils forming these sub - groups The values of C R s show that the sub-groups differ significantly from the sample in their measures on the predictor variables of the battery only Obtained differences between the means of Science students and Humanities students on all predictor variables excepting that on DR ability are very significant DR measures both Verbal and Deductive or Concrete Reasoning abilities The non-significance of the difference between the means of the sub-groups indicates that Humanities students are better in "Concrete Reasoning" than Science students This indicates that many students who have offered Humanities at the secondary level depict skill of hand more than deliberations of intellect In scholastic achievement the difference between the means of the sub-groups is significant at .05 level of confidence in favour of Humanities students The descriptive subjects - Civics, History, Geography - in the Humanities course fetch average passing marks at the hands of valuers easily while the reflective subjects - Physics, Chemistry, Maths - are comparatively difficult and result in extreme performance of students

The measurements of central tendency on the eight predictor variables of the two groups reveal that N, V IR abilities B1N and Science Interest discriminate in favour of science while B1N, V, N, DR IR and Humanities Interest, in that order differentiate in favour of Humanities With the highest value of DM, Science interest appears to be the best single differentiating variable in the battery followed by Numerical ability for the two courses of study in favour of Science

The higher the value of 6 of a group, the more heterogeneous it is All D6s excepting those on Humanities interest and Achievement are in favour of Humanities students. This means that the group of Humanities students is more heterogeneous in innate abilities (N, V, IR and DR), Personality (B1N and F1C) and Science interest than that of Science students It reflects again, on our poor screening or selection of students for diversified courses in secondary schools; especially the creaming - off selection of students for science course whereby students with average or lower achievement in VIII class - the remaining dump full of all diversities-has to be admitted into Humanities course The obtained difference between the dispersions of Science students and Humanities students is very significantly in favour of Humanities students on the criterion This denotes again that the Humanities group is more heterogeneous and includes slow learners and poor performers in Humanities These slow learners would have followed and showed better performances in other diversified or vocational courses than Humanities

The dichotomy of curricular interests - Humanities and Science - has been proved both by the factorisation of variables and regression They have also shown that the differential Aptitude Tests (N, V, IR and DR) cluster into two distinct groups to determine the two sub-criteria and that 'Interest' is a determiner of a course of study and a good differentiator for the two streams

Rotated Factors :

The intellective abilities have larger loadings on the first rotated factor General Scholastic Ability IR (Inductive Reasoning) has the highest loading (64) on it The interest-variables have nearly equal loadings on the first factor, the loading of Science interest (27) being in the +ve direction while that of Humanities interest (- 31) in the negative direction The Personality variables have very small loadings on the first factor.

This indicates that the general energy of mental activities in scholastic pursuits is intellective mainly, and Curricular or acquired interest is a good discriminator Together with intellective abilities non-intellective personality and interests shape scholastic achievement.

From the signs of the predictor variables in the two regression equations for the two sub-criteria it is clear that the eight tests group themselves into two operationally opposite camps - N, IR, B1N V and Sc Int in favour of Science and B1N, V, N, DR, IR and Hu Int in favour of Humanities in that order

The purposeful classification of students with the smallest probability of error of classification so that their scholastic pursuits in secondary schools could be fruitful and not a waste is obtained by applying a cut-off score to the composite score on the predictor variables of this battery It is clear that only 26 % of the Science and 22 % of the Humanities students from the general samples possess scholastic promise to prosecute these courses at the secondary stage and profit by them

The normally successful science students (90) appear to possess higher intellective abilities (excepting DR) and are more emotionally stable and confident in their scholastic pursuit than the general group of Science students The same is the case with normally successful Humanities students. Comparatively, the normally successful Science students are emotionally more stable than the selected Humanities students but they are less confident of their scholastic performance than the latter. This is in the expected direction The descriptive nature of the subjects - History, Geography, Civics, etc -forming the Humanities group and the reflective nature of the subjects - Chemistry, Physics, Maths - in the Science course are factors contributing to this direction of emotional differences This justifies the inclusion of both B1N and F1C scales in the predictive battery

The analysis of variance of u 'Between' and "Within" groups leads to the rejection of the null-hypothesis that the two groups - Science students and Humanities students - are identical The relative value of the variable α for discriminating between these groups is indicated by $\underline{\lambda}$ weights of the different measurements A value of $\bar{u}$ for the linear function u for a student from his scores on the eight variables of the predictive battery tells us convincingly whether he can be given either Humanities or Science course when he is to be admitted into a secondary school

A Retrospect

In the past, education often paid attention to every factor involved in the educative process - curriculum, methods, organisation, examinations except that which really counts, the student - his innate abilities, aspirations, interest, temperament and his needs. The Secondary Education Commission (1952-53) had therefore, suggested a diversity of educational programmes - in secondary schools to meet the varying abilities, interests and talents of students because they differ greatly in these, especially around adolescence, i. e about 14 + A proper selection of students for the diversified courses in accordance with differences in student-nature and the prediction of their scholastic achievements in these courses prior to their admission are the twin problems before us to arrest the huge wastage in our education

Presently, selection of students for diversified courses is done on their marks in the annual examination of VIII class Selection by this 'creaming off' process because of which intelligent students are sent to the Science course is educationally unsound and psychologically harmful Secondly, VIII class scholastic achievement which is saturated more with 'g' - general scholastic ability - is considered as indicative of the predictive power for final H S S. C. Examination This is statistically suicidal because the electives which depend more on the differential abilities shape the H.S S.C scholastic achievement

This study aims at offering psychological tests to know and measure the diversities of student nature - the differential aptitudes or the innate and current potentialities which denote relative promise for their further development in a field of study, the interests or the structural dispositions which determine the direction of future scholastic performonce and personality or the totality of a student's individuality.

Burt, Vernon, Eysenck etc. have shown that the tests of personality and interest when combined with the knowledge of student's intellectual ability make prediction considerably more accurate While scholastic ability is the power that governs, interest gives direction to this power and determines a specific field of study for its fuller utilisation.

N, V IR and DR factor-tests from Dr Varma's battery of Differential Scholastic Aptitudes' are selected to measure cognitive abilities An 'Interest Inventory' in which curricular activities from both Humanities and Science courses are grouped in twenty boxes of five items each, is constructed on the lines of the 'Devon Interest Test ' In this study, we have to confine ourselves to the revelation of personality of a student of 14 + through his style and form of work. Therefore, it has to be dealt at the non-cognitive level, more or less as a function of emotional integration and personality organisation and has to be measured by providing behaviour samples and miniature situations of every day life of a student. Neurotic tendency or Emotional stability and Confidence in oneself are the two traits of personality selected for measurement in this study from the six traits measured by Dr. Bernreuter's 'Personality Test' which is translated into *Marathi* with the kind permission of the author

The eight tests of the battery are administered to 640 students of Class IX in twelve secondary schools of Vidarbha The criterion - school marks in all the optional subjects of Humanities or Science of Class IX - though fallible, has to be used for further treatment One of the functions of this predictive battery of eight tests - N, V, IR, Sc. Int., Hu. Int., B1N and F1C lies in developing optimal differentiation among families of students Humanities and Science are the major streams opted - 76% schools offer these courses and 80% students are admitted into them - by students in secondary Schools Therefore, this investigation is confined to these streams only The distribution of age (15 05) is normal for IX class entrants. The mean age for boys is 15 5 and that for girls is 14.38. The sample of 640 students of Class IX represents the population of all students of Class IX offering Humanities and Science course because the standard errors of sample statistics (N 6 and r) are very small

The eight variables are factorised firstly by the centroid method and four factors are extracted. They are (1) General Scholastic Temperament - a general power factor with highest loadings of Personality variables and a dichotomy of Science and Humanities interest, (2) 'Personality' - (non-cognitive) factor which contrasts the non-intellective dynamic side of mind with the intellective functions and formation of interests, (3) 'Interest' (Curricular) and the last (4th) weaker factor. These four factors are further rotated by the Varimax method of rotation. The first rotated factor is *'General Scholastic Ability'*. Humanities Interest has negative loading on this factor while cognitive abilities have the highest positive loadings on it Unlike the centroid first factor, this general power factor appears to be an ability factor The second and third rotated factors are *Personality* (non-intellective) and *Interest* (Curricular or acquired) respectively as the initial centroid factors The fourth factor is clearer in the Varimax solution. Because of larger positive loadings of V and DR variables on this factors it is *Verbal or Linguistic Ability*. factor.

When factor-variances of all the factors (*centroid*) are considered together, *General Scholastic Temperament* accounts for 68% *Personality* (non-intellective) 22% and *Interest* (Curricular or acquired) for nearly 9% of the total variance contributed by them to the variables of the battery, while the rotated factors contribute the factor variances as *General Scholastic Ability* 29% and *Personality* 43.5%, *Interest* 16% and *linguistic Ability* 11.5% respectively

The most likely measurement in the criterion from the known measurements on the eight variables is predicted with the help of a regression equation Regression coefficients using all the predictor variables are calculated for Science and Humanities by the inverse matrix method and regression weights for the predictive battery on the two criteria are determined.

The multiple regression equation which is a means of combining different measures of the same object in order to derive a composite measure or score is used for prediction of the criterion measures and for determination of the importance or weight of each of a number of predictor variables Such a weight which a variable exerts individually in determining the criterion excludes the influence of other variables. The two equations are -

$$\bar{Y}\ \text{Sc} = .37 \times N + .28 \times IR + .16 \times V + 03 \times B1N$$
$$- 01 \times F1C - .03 \times \text{Hu Int.} - 22 \times DR + 23.46$$

and
$$\bar{Y}\ \text{Hu.} = .36 \times V + .20 \times N + .19 \times DR + .10 \times IR$$
$$+ 07 \times B1N + 03 \times \text{Hu. Int.} - .01 \times \text{Sc. Int}$$
$$- .05 \times F1C + 18.17$$

Besides the 'beta weights', optimal or effective weights - proportions of the total variance of the battery contributed by the variables-are calculated for the variables. They are -

$$6^2\ \text{Sc.} = 36.705\% = 17.49\%\ (N) + 11.68\%\ (IR)$$
$$+ 4.54\%\ (V) + 2.715\%\ (DR)$$
$$+ .21\%\ (B1N)$$

and
$$6^2\ \text{Hu.} = 36.16\% = 18.60\%\ (V) + 7.74\%\ (DR)$$
$$+ 6.95\%\ (N) + 3.47\%\ (IR)$$
$$+ 5\%\ (F1C)$$

It is very clear from the proportions of the percentage-variances contributed by the predictor variables to the composite that the differential aptitude tests (N, V, IR and DR) cluster into two distinct groups to determine the criteria When the criterion at hand - school marks of essaytype examinations - tests cognitive mind and that too V and M abilities mostly, the non-significant contributions of 'Interest' and 'Personality' which measure non-cognitive mind mostly, need no explanation When the variance contributed by our essay - examinations with its huge burden to subsequent achievement for prediction purposes ranges between 25 to 30%, the variances contributed by the predictor variables of the battery to Humanities and Science achievements are above 36% Moreover, the battery devolops optimal differentiation among the two courses of study

The directions of the difference between sub-group (Humanities and Science) and the sample means suggest that there are marked differences in abilities and traits possessed by students forming these sub-groups N, and IR - the intellective abilities-and 'Science interest' discriminate the sub-groups in favour of Humanities Science Interest appears to be the best single differentiating predictor in the battery followed by Numerical ability in favour of Science. The values and signs of regression coefficients support the above finding

Humanities students form a more heterogeneous group in comparison to that of Science students It reflects on the poor selection of students. The poor performers in Humanities would have shown better performances in professional courses-Agriculture, Commerce and Fine Arts Girls as a class possess less interest in Science. The group of Science students is heterogeneous also. There are very high and low scorers on Science interest among science students. This suggests that many low scorers (Science students) should have offered other courses than Science. Science students as a class and especially the girls who have offered science are better in IR ability or the 'general scholastic ability'.

Because the present selection of students for diversified courses is unscientific and results into huge wastage and stagnation of human talents, students with better promise for success are selected from the samples after applying cut-off scores to the composite of the scores on the eight variables in the two courses

Discriminant funtion solvss the problems of discriminating between different populations and classifying them properly The α value from the scaled scores on the tests of the predictive battery for Science is 1.15 and that for Humanities comes out to be -1.57. The critical point for the function α for the two courses of study is thus -.21 If the $\bar{u}$ value obtained by a student is below -.21 he is to be admitted into Humanities course while, if it is above -.21 he is to be assigned to the Science course. The analysis of variance of α "Between" and "Within" groups establishes the relative value of the variables α for discriminating between the two groups of students from their scaled scores on the predictor variables of the battery of this research.

Thus, this battery of eight variables offers a single classification battery which by means of differential weighting procedures, enables us to measure differential scholastic developments and predict, from the scores on variables of the battery at the beginning of secondary schooling, the scholastic achievements at the end of Class IX of students offering Humanities and Science courses in Secondary Schools.

A Prospect :

Every product of an educational system is to be gainfully utilized. While addressing a meeting of the State Education Ministers to discuss the main features of educational planning in the five year plan Dr. V. K. R. V. Rao, former Member, Planning Commission, has suggested marking of some "terminal points", at which students could give-up formal studies and take either to occupational training or actual occupations

It will be in the fitness of things to suggest here, the diversification of courses at the end of each terminal point The 11 + selection of students into 'Academic' and 'Practical' courses in England deserves our attention. The first terminal point in Indian system of education should be, also at 11+, and the diversification of courses be on the lines given below.-

(1)

$$11 + \begin{cases} \text{Academic} \\ \text{Practical} \end{cases}$$

Students for the two streams should be selected on the basis of 'General Scholastic Aptitude', and a manual or practical test at 11 + In the academic course, knowledge objective should be stressed more and students be provided with a course of general education; while in the practical stream skill objective will have to be insisted upon

The second terminal point has to be at 14 + The seven diversified courses proposed by Mudaliar Commission (1953) cater to varying abilities interests and talents of students

(2)

$$14 + \begin{cases} \text{Humanities} \\ \text{Science} \\ \text{Agriculture} \\ \text{Technology} \\ \text{Commerce} \\ \text{Fine Arts} \\ \text{Home Science} \end{cases}$$

The selecting of students for these streams should be on the basis of 'Differential Scholastic Aptitudes' Interest and Personality and not on the basis of school-marks in the VIII Class annual essay-type examination as is prevalent now

The third terminal point needs to be at 16 + , when general education-languages, Social studies, Sciences and Elementary Maths. - has to be stopped Here-after students are to be led gradually to the fields of specialization according to their abilities, interests and personality This demands that they should be taught only optional subjects in the diversified courses in Higher Secondary Schools for two years

(3)

$$16 + \begin{cases} \text{Academic (Diversified courses)} \\ \text{Vocational - Technical} \end{cases}$$

Side by side with the diversified courses vocational courses-Teaching, Nursing, Workshop Practice, Clerical work Accountancy, printing and typography be instituted so that those who are fit for higher learning at the University stage (and the percentage of those students should not be more than 20%) will prosecute their studies further in optional subjects of the diversified courses in Universities. The rest 80% will be learning vocations to stand on their own legs after they go out of the secondary stage at 18 +. Selection of students for vocational courses will have to be done on the basis of 'Special Aptitude Tests', Interest and Personality.

To sum up in brief, there are five areas of information which have particular significance in understanding an adolescent when he is to be offered schooling in general and secondary education in particular

They are :-

1 General Scholastic Aptitude
2 Differential Scholastic Aptitude
3 Curricular Interest
4. Personality
and 5 Scholastic Achievement

Those whose concern is secondary education have to be familiar with this 'Scholastic Panchasheel' and should be able to develop and measure development of pupils periodically under their charge with the help of tests contructed to measure them

An attempt to shorten the predictive battery of eight variables so that it would be easier to handle it in actual practice i. e in selecting students for the two academic courses of study - Science and Humanities - when students are to be admitted into secondary schools, is worth consideration for the follow-up

REFERENCES

Adams & Torgerson	1957	Measurement and Evaluation
Anastasi A	1954	Psychological Testing
	1957	Differential Psychology
Berrill N. J	1957	Man's Emerging Mind
Bhattacharya S	1963	Guidance in Education
Boaz G. D	1957	General Psychology.
Brown & Thomson	1940	The Essentials of Mental measurement
Burt C	1940	The Factors of the Mind
Carrel A	1959	Man, the Unknown
Cattell R B	1948	A Guide to Mental Testing.
Cattell R B	1950	Personality
Cattell R B	1952	Factor Analysis.
Crawford & Burnham	1946	Forecasting College Achievement - A survey of Aptitude Tests for Higher Education
Coombs P H	1968	The World Education Crisis.
Cronbach L J	1946	Essentials of Psychological Testing
Dent H. C	1948	Education in Transition
Durant W.	1961	The Story of Philosophy.
Eysenk H. J.	1950	Dimensions of Personality.
Fisher R A.	1948	Statistical Methods for Research Workers.
Fleming C M	1948	Adolescence.
Flugel J. C	1953	A Hundred Years' of Psychology
French J W	1940	The Description of Aptitude and Achievement Tests in terms of rotated Factors.
Fruchter B		Introduction to Factor Analysis
Garrett H. E	1941	Great Experiments in Psychology
Garrison K C	1951	Psychology of Adolescence.
Good, Bar & Scates	1954	Methods of Educational Research.
Goulden C H.	1959	Methods of Statistical Analysis.
Guilford J. P.	1954	Psychometric Methods

Gullikeen H	1950	Theory of Mental Tests.
Holzinger K J	1948	Factor Analysis
Harman H H	1964	Modern Factor Analysis.
Hull C L		Aptitude Testing
Hurlock E B	1955	Adolescent Development.
Isaac S	1945	Intellectual Growth in Young Children.
Jersild A T	1957	The Psychology of Adolescence
Jersild and Tasch	1949	Children's Interests and What they suggest for Education.
Johnson P O	1950	Statistical Methods in Research
Jordan A M	1953	Measurement in Education - An Introduction
Kabir H	1959	Education in New India
Lindquist E F	1940	Statistical Analysis in Educational Research.
Lindquist E F.	1951	Educational Measurement
Livingstone R		The Future in Education
Mace C A and Vernon F.	1953	Current Trends in British Psychology
McClelland W	1949	Selection for Secondary Education.
Menon T K N	1961	Recent Trends in Psychology
Menon T K N	1961	Recent Trends in Education.
Murphy G	1947	Personality
Nortcut	1953	The Psychology of Personality
Pande N R W	1962	Abilities and Education.
Peel E A	1958	The Psychological Basis of Education.
Radhakrishnan S and Raju P T		The Concept of Man
Radhakrishna	1952	Advanced Statistical Methods in Biometric Research.
Richardson C A	1955	An Introduction to Mental Measurement and its Application
Russell B	1956	Education and the Social Order

Schwartz and Tiedeman	1957	Evaluating Student Progress
Singh R P	1960	Secondary Education in Modern Democracies
Skinner	1950	The Behaviour of Organisms
Spearman C & Jones W L L	1951	Human Ability
Stagner R	1948	Psychology of Personality
Stansfeld Sargent	1951	Basic Teachings of the Great Psychologists
Strong E K	1948	Vocational Interests of Men and Women
Thomson G H	1949	Instinct Intelligence and Character.
Thomson G H	1950	The Factorial Analysis of Human Ability
Thorndike R L	1949	Personnel Selection
Thorndike R L and Hagen	1955	Measurement and Evaluation in Psychology and Education
Thurstone L L	1949	Multiple Factor Analysis.
Thurstone L L	1957	Primary Mental Abilities
Traxler A E.	1949	Introduction to Testing and the Use of Test Results in Public Schools
Travers R M. W	1958	An Introduction to Educational Research
Uday Shankar	1953	Development of Personality
Valontine C. W	1957	Psychology, Its Bearing on Education.
Varma M.	1965	An Introduction to Educational and Psychological Research
Vernon P. E.	1950	The Structure of Human Abilities

Vernon P E	1953	Personality Tests and Assessments
Vernon P E	1956	The Measurement of Abilities
Vernon P E	1957	Secondary School Selection
Vernon P E	1962	Intelligence and Attainment Tests
Webster E C		Guidance for the High School Pupil - A Study of Quebec Secondary Schools

JOURNALS

The British Journal of Educational Psychology.

Alexander W P	1947	Symposium on the selection of Pupils for different types of Secondary Schools, 17-3
Astington E	1960	Personality Assessments and Academic Performance in a Boy's Grammar School
Burt C.	1947	Multiple Factor Analysis - Review
Burt C	1955	Evidence to support the conception of an 'innate' general intellectual factor.
Chown S. M	1959	Personality factors in the formation of occupational choice
Chown S M	1959	The value of Measures of Persistence in selection for Secondary Education,
Dale R R	1960	Reflections on Research on Allocation to Secondary Education
Kelley P J	1961	An Investigation of the factors which influence Grammar School Pupils to prefer Scientific subjects
Lambert	1949	A survey of Ability and Interest at the stage of transfer

Lynn R	1959	Two Personality Characteristics Related to Academic Achievement
Meyer G R & Penfold D M E	1961	Factors Associated with Interest in Science
Peel	1948	Assessment of Interest in Practical Topics
Richardson S C	1956	Some evidence relating to the Validity of Selection for Grammar Schools
Rowlands & [illegible]	1961	Scientific Concepts and Interest in Science - Symposium
Wilson M. D	1953	The Vocational Preferences of Secondary Modern School Children
Wiseman S	1955	The Use of an Interest Test in 11 + Selection
Wiseman S B Fitzpatrick		An Interest Test for use in Selection for Technical Education
Wiseman S	1959	Trends in Educational Psychology

Educational Research

Burt C.	1959	General Ability and Special Aptitudes

Educational and Psychological Measurements

Levine A S	1958	Aptitude Versus Achievement Tests as predictors of Achievement.
Lord F M	1955	Estimating Test Reliability. 15-4
McQuilty L & Eorehand G	1959	Configurations of Factor Standings as predictors of Educational Achievement
Racky D J	1959	Performance from Aptitude and Interest Measures.
Toops H. A.	1945	Philosophy and Practice of Personnel Selection

Journal of Educational Psychology

Berdie R F	1951	The Differential Aptitude Tests as predictors in Engineering Training
Brogden H E	1946	On the Interpretation of the Coefficient of Corretation as a Efficiency.
Doppelt J E & Wesman A G	1952	The Differential Aptitude Tests as Predictors of Achievement Test Scores
French J W & Tucker L R	1952	A Factor Analysis of Aptitude and Achievement Entrance Tests and United States Coast Guard Academy
Krathwohl W C	1953	Relative Contributions of Aptitude and Work habits to Achievement in College Maths
Hotelling H	1935	The most Predictable Criterion
Kelley T. L	1939	The Selection of Upper and Lower Groups for the validation of Test items
Melton W B	8956	An Investigation of the relationship between Personality and Vocational Interest
Thorndike E L	1950	Traits of Personality and their Inter Co-relations as shown in Biographies.

The British Journal of Statistical Psychology

Burt C	1943	Validity Tests for Personnel Selection
Burt C	1950	Group Factor Analysis.
Howard M	1958	The Conversion of Scores to a Uniform Scale.
Mukherjee B N	1962	The Factorial Structure of Aptitude Tests at Successive Grade Levels

Peel E A	1959	The Measurement of Interests by Verbal Methods
Rao C R and Slater P	1949	Multivariate Analysis Applied to Differences between Neurotic Groups
Vernon P E	1950	An Application of Factorial Analysis to the study of Test items
Wrigley C.	1952	The Prediction of a Complex Aptitude

British Journal of Psychology

Burt C	1949	The two-Factor Theory
Raath M T and Reyburn H. A	1950	Primary Factors of Personality
Thomson G H	1947	Weighting for Battery Raliability and Prediction.

Psychometrika

Brogden H. E	1946	An Approach to the Problem of Differential Prediction
Cottle W. M C	1950	A Factorial Study of the Multiphasic, strong, Kuder and Bell Inventories using a population of Adult Males
Denton J C. & Taylor C W	1955	A Factor Analysis of Mental Abilities and Personality Traits.
Garrett H E	1945	The Discriminant Function and Its Use in Psychology
Gengerelli J A	1948	A simplified method for approximating Multiple Regression Coefficients
Goodman C H.	1943	A Factorial Analysis of Thurstone s Seven Primary Abilities

Green F R	1953	A Factor Analytic Study of Reasoning Abilities
Guilford J P and Michael W B	1949	Prediction of Categories from Measurements
Guttman L & Cohen J	1943	Multiple Rectilinear Prediction and the Resolution into Components
Horst P	1936	Obtaining a composite measure from a number of different measures of the same thing
Horst P	1956	Optimal Test Length for Maximum Differential Prediction
Mollenkopf W C	1950	Predicted Differences and Differences between Predictions
Mosier C I	1943	On the Reliability of a Weighted Composite
* Thorndike R L	1950	The Problem of Classification of Personnel
Zimmerman W S	1953	A revised Orthogonal Rotational Solution for Thurstone s Primary Mental Abilities Test Battery

REPORTS

1 The Seminar on Examinations,
All India Council for Secondary Education, Delhi, 1956

2 Selection and Linear Combination of Tests in Relation to Multiple Criteria and Differential Classification,
Dwyer P S , Department of the Army, P R. B. Research Note 7, 1953

3 Measurement of Achievement in Mathematics,
Gayen A K , 1961

4 An outline of the Statistical Theory of Prediction,
Horst P , et alia

---

* Personal Communication to the Author

5 Fifteen to Eighteen,
The Central Advisory Council for Education
H. M Stationery Office, 1959.

6 Exploring Children's Interests,
Kuder G F & Paulson B. B
Science Research Associates, Chicago

7 The Secondary Education Commission,
Dr Mudaliar L, Government of India 1953

8 The Measurement of Understanding
Forty-Fifth Year Book
The National Society for the study of Education
Chicago, 1952

9 Testing and Counseling in the High School Guidance
Program
Science Research Associates, Chicago 1943

10 Statistical Investigations on Some Problems pertaining to
the Results of the S. S C Examinations
Secondary School Certicate Examination
Board, Poona, 1960

11 The University Education Commission,
Dr Radhakrishnan S, Government of India 1949

12 The Assessment of Children,
Vernon P E., Studies in Education, Institute
of Education, London, 1955.

APPENDIX-A

PERCENTILE NORMS

(A) Differential Scholastic Aptitudes

(General Sample) N = 640

Percentile	N	V	IR	DR
100th	60	55	45	50
90th	41	38	33	45
80th	37	33	29	44
75th	35	32	28	43
70th	34	30	27	42
60th	31	28	25	41
50th	28	25	23	40
40th	26	23	21	39
30th	23	21	18	37
25th	21	20	16	36
20th	20	18	14	35
10th	15	15	8	32

Percentile Norms

(B) Personality (B1N and F1C)

	General (640)		So St (344)		Hu. St (296)	
Percentile	B1N	F1C	B1N	F1C	B1N	F1C
100th	150	160	150	160	150	160
90th	51	85	41	72	58	94
80th	26	56	17	46	37	69
75th	16	44	8	33	27	56
70th	7	32	- 1	21	17	44
60th	- 9	10	-16	3	- 2	22
50th	-23	- 4	-30	- 8	-16	2
40th	-39	-17	-45	-20	-30	-13
30th	-55	-32	-60	-35	-47	-29
25th	-63	-40	-70	-42	-56	-37
20th	-73	-47	-80	-49	-65	-45
10th	-92	-70	-105	-74	-84	-66

PERCENTILE NORMS

(C) Interest (Science)

Percentiles	General (640)	Sc St (344)	Hu St (296)
100th	70	70	70
90th	60	63	49
80th	55	60	44
75th	53	58	42
70th	51	56	41
60th	47	53	38
50th	43	50	36
40th	39	47	32
30th	35	44	29
25th	33	43	27
20th	30	40	24
10th	24	32	20

PERCENTILE NORMS

(D) Interest (Humanities)

Percentiles	General (640)	Sc St (344)	Hu St (296)
100th	70	63	70
90th	50	47	54
80th	46	42	48
75th	44	40	47
70th	42	39	45
60th	39	36	42
50th	36	32	40
40th	32	29	37
30th	28	24	34
25th	26	22	31
20th	23	19	29
10th	16	13	23

MATRIX OF INTERCORRELATIONS
(GENERAL N = 640)

	N	V	IR	DR	Hu.Int	Sc.Int.	B1N	F1C	Ach.
N	—	3199	3501	1398	- 0598	.2207	1906	.1504	.2764
V	—	—	4212	.3770	-.0185	.1833	.0933	.0409	.3055
IR	—		—	.2602	- 0104	.1806	.0843	.0627	.3184
DR	—	—	—	—	0152	.0601	0883	.0622	.1262
Hu Int	—	—	—	—	—	-.4089	-.1196	-.0790	.0226
Sc Int	—	—	—	—	—	—	.1188	.1308	- 0217
B1N	—	—	—	—	—		—	8595	.1307
F1C	—	—	—	—	—	—	—	—	.1167

⁂

APPENDIX-B
MATRICES
MATRIX OF INTERCORRELATIONS
SCIENCE STUDENTS
344

M	N	IR	V	B1N	F1C	Sc Int.	DR	Hu Int
N	1	2569	.2694	0868	0850	0469	.0498	0340
IR	2569	1	3518	1234	1090	0492	.0765	- 0792
V	2694	.3518	1	.1309	0709	1191	3432	1025
B1N	0868	.1234	.1309	1	8525	.1232	0982	- 1135
F1C	0850	1090	.0709	.8525	1	1591	0790	- 1035
Sc Int	0469	0492	1191	.1232	.1591	1	.0855	- 0678
DR	0498	.0765	3432	.0982	.0790	.0855	1	0244
Hu Int	0340	-.0792	1025	- 1135	-.1035	0678	.0224	1

INVERSE MATRIX OF INTERCORRELATIONS
(SCIENCE)

-1 M	N	IR	V	B1N	F1C	Sc Int.	DR	Hu Int
Check1	1211	- 2041	2380	0149	- 0747	- 0107	.0477	-.0377
N	1 0000	- 1821	2123	0133	- 0666	- 0095	0425	- 0336
IR	- 2041	1.2061	-.3982	- 0165	- 0654	0142	0565	1344
V	- 2380	- 3980	1 3996	- 2752	.2329	1241	-.4142	- 1722
B1N	.0150	-.0164	- 2752	3.7106	-3.1278	.0851	- 0327	1307
F1C	-.0746	-.0654	.2328	-3.1276	3 6856	-.2197	- 0358	- 0140
Sc.Int	-.0107	.0142	-.1241	.0851	-.2198	1 0466	- 0435	0721
DR	.0477	.0565	- 4143	- 0327	- 0358	- 0435	1 1450	.0071
Hu Int	- 0377	1345	- 1722	.1305	- 0140	0722	0072	1 0477

MATRIX OF INTERCORRELATIONS
HUMANITIES STUDENTS
(296)

M	V	IR	DR	N	B1N	F1C	Hu Int	Sc Int
V	1	4004	4080	2114	0023	.1183	0301	- 0187
IR	4004	1	2265	2895	- 0362	- 0721	.0419	0517
DR	.4080	2265	1	.2075	.0614	0225	1074	0215
N	.2114	2895	2075	1	.2109	.2369	1004	0155
B1N	0023	-.0362	0614	2109	1	8734	- 0261	- 0446
F1C	1183	- 0721	.0225	.2369	8734	1	0215	0021
Hu Int.	.0301	.0419	.1074	.1004	- 0261	0215	1	- 1235
Sc Int.	- 0187	.0517	0215	.0155	- 0446	0021	- 1235	1

- INVERSE MATRIX OF INTERCORRELATIONS -
(HUMANITIES)

-1 M	V	IR	DR	N	B1N	F1C	Hu Int	Sc Int
Check	1 5585	-.5324	- 5488	- 0532	8636	- 9547	0978	1220
V	1 0000	- 3417	- 3522	- 0341	5543	- 6127	0628	0783
IR	- 5319	1 4487	0501	- 7120	- 4086	6919	- 0161	- 0965
DR	- 5490	0503	1 3157	- 3343	- 5046	5619	- 1280	- 0755
N	- 0537	- 7119	- 3342	2 6567	- 0440	- 6912	- 1856	- 0183
B1N	.8638	4096	- 5047	0450	4 8327	-4 3586	2999	3099
F1C	- 9547	6933	5617	6925	-4 3566	5 1257	- 2509	- 2914
Hu Int	0979	- 0161	- 1279	- 1855	2999	- 2510	1 0623	.1533
Sc Int	1220	- 0967	- 0755	- 0185	3100	- 2916	1534	1 0426

APPENDIX-C

R's BETWEEN PREDICTED ACHIEVEMENTS AND SCHOLASTIC ACHIEVEMENTS

PREDICTED C Sc AND OBTAINED C Sc
(GENERAL - 344)

	15-19	20-24	25-29	30-34	35-39	40-44	45-49	fy	y'	fy'	fy'2	Ex'y
55-59					1	1		2	+ 4	8	32	20
50-54				3	4	1	2	10	+3	30	90	66
45-49		1	9	6	8	4	1	29	+2	58	116	74
40-44	1	10	25	37	21	5	1	100	+ 1	100	100	86
35-39	8	26	39	26	6	2		107	0	0	0	0
30-34	13	26	26	11	2			78	-1	-78	78	37
25-29	2	9	3	1	1			2	-2	-32	64	20
20-24	1	1						0	-3	- 6	18	9
fx	25	73	102	84	43	13	4	344		80	498	312
x'	- 2	- 1	0	+ 1	+2	+3	+4					
fx'	-50	-73	0	84	86	39	16	102	r =	54		
fx'2	100	73	0	84	172	117	64	610				
Ex y'	38	35	0	45	98	60	36	312				

PREDICTED C Hu AND OBTAINED C. H.

(GENERAL - 296)

	15-19	20-24	25-29	30-34	35-39	40-44	fy	y'	fy'	fy'2	Ex'y'
60-64						2	2	+4	8	32	16
55-59				3	2	1	6	+3	18	54	12
50-54		1	7	12	4	2	26	+2	52	104	2
45-49		11	25	31	17	2	86	+1	86	86	26
40-44	1	15	39	47	7	3	112	0	0	0	0
35-39	2	12	27	14			55	-1	55	55	57
30-34	2	2	4				8	-2	-16	32	28
25-29		1					1	-3	- 3	9	6
fx	5	42	102	107	30	10	296		90	372	91
x'	- 3	- 2	- 1	0	+1	+2					
fx'	-15	-84	-102	0	30	20	-151	r = 4214			
fx'2	45	168	102	0	80	40	385				
Ex'y'	18	12	- 4	0	31	34	91				

$L_1 + .99\ L_2 + L_3 + L_4 + 99\ L_5 + .72\ L_6 + 96\ L_7 + L_8 = 9\ 70$
4176

$99\ L_1 + L_2\ 99\ L_3 + L_4 + 97\ L_5 + 67\ L_6 + 98\ L_7 + 91\ L_8 = 24$
3709

$L_1 + .99\ L_2 + L_3 + L_4 + .99\ L_5 + 71\ L_6 + 97\ L_7 + 99\ L_8 = 5\ 32$
3292

$L_1 + L_2 + L_3 + L_4 + L_5 + 63\ L_6 + L_7 + L_8 = -2\ 98$
4321

$.99\ L_1 + 97\ L_2 + 99\ L_3 + L_4 + L_5 + 82\ L_6 + 93\ L_7 + .99\ L = 19\ 06$
4624

$.72 L_1 + 67\ L_2 + .71\ L_3 + 63\ L_4 + 82 L_5 + L_6 + 50\ L_7 + 79\ L_8 = 21\ 56$
1296

$96\ L_1 + .98\ L_2 + 97\ L_3 + L_4 + 93\ L_5 + 50\ L_6 + L_7 + 94\ L_8 = 11\ 17$
3806

$L_1 + 98\ L_2 + .99\ L_3 + L_4 + 99\ L_5 + 79\ L_6 + 94\ L_7 + L_8 = 14\ 01$
4960

APPENDIX-E

INTERST INVENTORY

⁂

(Author's permission is necessary for the use of this Inventory)

⁂

Student Arts / Science

Date Age

School Class

⁂

Dr. M. B. Pande
3, Farmland
Ramdaspeth
NAGPUR

"Karmani Pravibhaktani swabhava prabhavairgunaih"

All publication rights in all languages reserved by Paramarsha Prabodhini, Bhagirah. 3 Farmland, Ramdaspeth, NAGPUR.

LIKES and DISLIKES

From the various activities you desire to perform it is intended to know the diversified course you are interested in For students offering Humanities and Science courses of study twenty groups of five activities each in which students of your age are generally interested in are given below

Select one group of five activities at a time and think about the activities one by one

(1) Out of the five activities place tickmarks against activities which you like in the 'Like' column

(2) Place tick-marks against activities which you do not like in the 'Dislike' column

(3) If you are doubtful about your liking for an activity place a tick-mark in the '?' column.

(4) Out of the five activities place a tick-mark against the activity which you like most in the 'Like most' column

(5) Place a tick-mark against the activity which, you dislike most in the 'Dislike most' column

(6) After Completing one group of five activities select the next group and proceed as directed above

Study the following example before you start

	like	?	Dislike	like most	Dislike most
1 To take part in debate, seminars etc			√		√
2. To hear literary Lectuves			√		
3 To prepare soap, cosmetics etc,	√			√	
4 To write articles on scientific subjects.	√				
5 To study different scripts			√		

A student has expressed his likes and dislikes as shown in the above example. He has liking for Scientific activities (Item No. 3 and 4) but has expressed his disliking for the three Humanities or arts activities Out of the five activities he likes the third item (To prepare soap, cosmetice etc) most and the first item (To take part in debate, Seminar etc) the least.

Do not turn the leaf unless you are asked to do it

1

	Like	?	Dislike	Like most.	dislike most
1 Performing experiments in laboratary					
2 Reading science stories					
3 Reading historical novels					
4 Collecting old coins					
5 Seeing mines					

Hu	Sc

2

	Like	?	Dislike	Like most.	dislike most
6 Preparing albums of tree leaves					
7 Observing a bridge under construction					
8 Collecting postal stamps of different countries					
9 Seeing Ashoka pillar, caves, ancient temples etc					
10 Observing customs of various tribes					

Hu	Sc

3

	Like	?	Dislike	Like most	Dislike most
11 Seeing electric power station					
12 Solving problems in Mathematics					
13 Looking into atlas in leisure					
14 Reading articles and books on journeys					
15 Observing human skeleton and different parts of it in dispensaries					

Hu S

4

	like	?	Dislike	Like most	Dislike most
16 Enlisting in air force					
17 Observing take-off or landing of an aeroplane on aerodrome.					
18 Contesting elections in schools					
19 Visiting exhibition of historical objects					
20 Reading or observing deliberations of legislative assembly					

Hu S.

5

	Like	?	Dislike	Like most	dislike most
21 Visting science exhibition	—	—	—	—	—
22 Observing axamination of a patient by a doctor	—	—	—	—	—
23 Hearing lectures of leaders in conferences	—	—	—	—	—
24 Collecting pictures of leaders of other countries	—	—	—	—	—
25 Mending a bicycle.	—	—	—	—	—

Hu	Sc

6

	like	?	Dislike	like most	Dislike most
26 Getting information obout machines	—	—	—	—	—
27 Handling carpenter's tools	—	—	—	—	—
28 Learning history	—	—	—	—	—
29 Reading information about prominent cities of the world.	—	—	—	—	—
33 Collecting information about customs of other provinces	—	—	—	—	—

Hu.	Sc

7

		like	?	Dislike	like most	Dislike most		
31	learning science subjects							
32	Making minor repairs							
33	Writing a poem or a story							
34	Taking part in memorisation or Bhandaya Competition							
35	Observing electric repairs						Hu	Sc

8

		like	?	Dislike	like most	Dislike most		
36	Preparing model for science exhibition							
37	Observing movements of engines.							
38	Collecting information about leaders of our country							
39	Reading information about political developments							
40.	Hearing public speeches of our leaders						Hu	Sc

9

	Like	?	Dislike	like most	Dislike most
41 Preparing mechanical toys or other things					
42 Observing different flowers					
43 Collecting historical pictures					
44 Reading information about other countries					
45 Reading information about scientific Institutions					

Hu	Sc

10

	like	?	Dislike	like most	Dislike most
46 learning about colours and shapes of flowers					
47 Reading daily temparature and weather reports					
48. Reading political information in news papers and magazines					
49 Taking part in school elections.					
50 Collecting information about different localities of my town					

Hn	Sc

11	like	?	Dislike	like most	Dislike most
51 Mending articles which are out of order					
52 Reading science information in news papers and magazines					
53 Observing deliberations in loksabha or Vidhan sabha					
54 Reading information about the customs of different countries.					
55 Spending leisure in science clubs.					

Hu.	Sc

12	Like	?	Dislike	Like most	dislike most
56 Observing factories					
57. Observing stars and planets in the sky					
58 Visiting historical places					
59. Reading biographies of leaders					
60. Seeing historical dramas					

Hu.	Sc

13	Like	?	Dislike	Like most	Dislike most
61 Collecting specimen stones, conch shells metalic pieces etc					
62 Reading history of scientific research					
63 Reading Savarkar's 'war of Independence' of 1857.					
64 listening historical ballards					
65 Reading reference books when doubts regarding scientific information arise					

Hu	Sc

14	Like	?	Dislike	Like most	Dislike most
66 listening science lessons on radio.					
67 listening daily weather forecasts on radio					
68 listening daily news given by repoters on radio					
69 listening short plays on radio					
70 Seeing historical films					

Hu	Sc.

15

		Like	?	Dislike	Like most	Dislike most
71	Visiting Transmitting centre of AIR					
72	Seeing scientific films					
73	Reading reference books like book of knowledge, world Dictionary etc					
74	listening puranas kirtans etc					
75	Preparing paper boats, paper aeroplanes etc					

Hu	Sc

16

		Like	?	Dislike	Like most	Dislike most
76	Collecting information about plants					
77	Observing construction of nests of birds					
78	Taking part in political discussion					
79	Reciting sanskrit shlokas after getting up in the morning					
80	Being editor of a magazine					

Hu	Sc

17		like	?	Dislike	like most	Dislike most
81	Collecting information about various birds					
82	Observing science teachers carefully while performing experiments					
83	Taking signatures and autographs of political leaders					
84.	Collecting pictures of flags of different nations					
85	Collecting pictures of rockets, sputnics					

Hu	Sc

18		like	?	Dislike	like most	Dislike most
86	Observing lighting arrangments of pandals					
87	Observing changes as falling of leaves, appearance of shoots, blosoming of fowers formation or fruits etc , when the seasons change.					
88	Keeping information of ministers and their portfolioes.					
89	Teaching illiterates to write and read					
90	Reading books from libraries regularly					

Hu	Sc

19

		Like	?	Dislike	Like most	Dislike most
91	Observing different colours of a rainbow					
92	[illegible] telephone from [illegible] box					
93	Fixing [illegible] [illegible] room					
94	[illegible] at home					
95	Collecting medicines [illegible] illnesses					

20

		Like	?	Dislike	Like most	Dislike most
96	To be an [illegible] in the field of [illegible] life					
97	To be a navigator of a rocket to the moon					
98	To be a ministe					
99	To be a social reformer					
100	To be a saint or religious preacher					

Methodology of Teaching Science

Deoyani P Shinde Rs 30/-

A Text book for Bachelor of Education students and a valuable reference for science teachers in high schools, covers extensively the methods by refering to the new syllabus followed in Andhra Pradesh, Maharashtra and other states

It is appropreately illustrated and contains examples from chemistry, physics and biology

Urban Arts,
Publications Division,
A 201, Satya Apartment, Masab Tank
Hyderabad, 500 028

(20% discount if more than 10 copies are ordered at a time, postage extra)